Burgdorfer, Willy 1986

Dr. Willy Burgdorfer Oral History 1986

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Deirdre Boggs:
I interviewed Dr. Willy Burgdorfer on tape in three different sessions, beginning on July 10, 2001, and ending in August. After reading the transcribed version of the interviews, Dr. Burgdorfer wished to make some changes and refinements to the answers that he gave to the interview questions. He finished making the desired changes at the beginning of October 2001. The following transcription reflects Dr. Burgdorfer's oral responses to the interview questions as later edited and supplemented by Dr. Burgdorfer.

This is Deirdre Boggs of Historical Research Associates interviewing Dr. Willy Burgdorfer in Hamilton, Montana on July 10, 2001. The interview is being done at the request of the National Institutes of Health.

DB: Dr. Burgdorfer, I'd like to begin by asking you where you grew up and what your first language was?

WB: I was born and grew up in Basel, Switzerland. Basel is in the northwest corner of the country where German is spoken, so my mother tongue is German.

DB: Where and how did you learn to speak English?

WB: I became exposed to the English language for four years in gymnasium.

DB: Can you still speak German?

WB: Oh, yes.

DB: And do you ever speak German anymore?

WB: Yes, I do. Some of my correspondence is still written in German.

DB: Although you've been speaking English for many years. Isn't that true?

WB: Yes.

DB: For over 50 years?

WB: That's true.

DB: Did your parents encourage you to attend university?

WB: Yes, both my mother and father did. Mother wanted me to become a teacher, but Dad suggested I become a research scientist to eventually seek a position in one of Basel's pharmaceutical companies such as CIBA, Sandoz, Hoffman La Roche, Geigy and others. I followed Dad's advice and included in my curriculum at the university zoology, bacteriology, entomology, parasitology and hygiene.

DB: And where did you go to college?

WB: In Basel.

DB: What's the name of the university that you attended?

WB: University of Basel.

DB: When did you start your university studies?

WB: I started my studies in 1944, right after I passed the final exam from the gymnasium.

DB: And is the gymnasium similar to our high school in this country?

WB: Yes it is.

DB: So when you started out at the University, you already had an interest in scientific research. Is that correct?

WB: Yes, because during the gymnasium years I liked biology and parasitology.

DB: When you were at the University, did any particular professor influence your choice of studies?

WB: Yes, there were two professors. One was Professor Rudolf Geigy, who was professor of zoology and also the Director of the Swiss Tropical Institute. The second one was Professor [J.] Tomcsik, who liked to lecture about diseases transmitted by arthropods.

DB: What is the Swiss Tropical Institute?

WB: The Swiss Tropical Institute was founded by Professor Geigy as a research institute to study certain tropical diseases. It also served as a training center for persons (especially medical staff) wanting to move to and live in tropical countries. It also is a treatment center for persons who have contracted diseases while living in the tropics.

DB: Did you go on to do graduate study at the University of Basel.

WB: Yes. At first I had to do undergraduate work under the guidance of Professor Geigy. This had to be done by anyone wanting to become a graduate student studying for a Ph.D. My undergraduate work concerned the development of trypanosomes in Swiss mice.

DB: And what are trypanosomes?

WB: Trypanosomes are protozoa agent that can cause various diseases, especially in the tropics. The trypanosome I was working with was Trypanosoma brucei, an agent that is quite regularly found in wild animals and animals throughout Africa.

DB: You said you were influenced by Dr. Geigy. Did you actually do your Ph.D. study and dissertation under him?

WB: That's correct.

DB: And what in particular did you study when you were doing your Ph.D. dissertation.

WB: Well, my prime study was to determine the development of the relapsing fever spirochete called Borrelia duttoni in the soft tick Ornithodoros moubata – from the moment the tick becomes infected to the moment it is able to transmit this organism to patients.

DB: How did you come up with this Ph.D. topic?

WB: This topic was actually of interest to Professor Geigy, who quite often went on safari in Africa to study African diseases transmitted by arthropods, especially by ticks.

DB: You've talked about spirochetes and you've talked about arthropods. Could you give us a very quick definition of arthropods?

WB: The arthropods are invertebrate animals characterized by joint legs, tough exoskeleton and segmented body. They include insects and spiders, also ticks. Spirochetes on the other hand are slender, flexible, helical bacteria about 3 to 500 micrometers in length. They are motile with characteristic rotational and translational movements due to flagella located at both ends of the organism.

DB: So spirochetes are microorganisms?

WB: Yes. They multiply by binary fission. It is being postulated in work currently in progress that they undergo far more complex development.

DB: And is it the flagella that allow the spirochete to move?

WB: Yes.

DB: When you were starting your graduate work on relapsing fever, what was already known about the agent that causes this disease? Had the agent been identified yet?

WB: The agent of relapsing fever was identified long time before that. This was in the middle of the 19th Century when Europe suffered epidemics of louse-borne relapsing fever. The disease, its transmission by lice, and its cause by Borrelia recurrentis, were discovered in the middle of the 19th Century by Dr. Obermeier in Germany. At the beginning of the 20th Century, it was found that organisms similar to the European spirochetes, were transmitted in Africa by the African tick Ornithodoros moubata.

DB: And when you started your study did you already know about the louse transmitted relapsing fever?

WB: Oh, yes. Oh, yes. The old literature describes in great detail how the organism was found by Dr. Obermeier who was looking for something completely different, and then while examining the blood of a patient, found those snake-like organisms, the spirochetes.

DB: Are there carriers other than the ticks and lice for the agent that causes relapsing fever?

WB: No, as far as relapsing fever is concerned, you have the louse-borne and a large variety of tick-borne relapsing fevers.

DB: Had you developed any interest in ticks prior to your beginning to study relapsing fever?

WB: Yes, just a little bit because of the lectures and courses I attended at the Swiss Tropical Institute on tick- borne diseases. So I had some introduction into the subject.

DB: And again, your topic of study for your graduate work was an area that Dr. Geigy was especially interested in. Is that true?

WB: That's correct.

DB: Was he specific about what he wanted you to pursue when you were working on your Ph.D. under him?

WB: Yes, he was very specific. As I said before, he wanted to know what happens to the spirochetes once the tick picks them up from an infected host, particularly what tissues of the tick become infected and how the tick transmits the organism to human patients.

DB: Did he tell you how to go about figuring these things out?

WB: No. It was up to me to work out the research to solve the problems. Of course, he periodically reviewed the results.

DB: How did you go about pursuing this study?

WB: Well, one of Dr. Geigy's interests was the epidemiology of tick-borne relapsing fever in East Africa, particularly in Tanzania. He wanted to know the prevalence of infected Ornithodoros moubata throughout that country. To do this, he collected hundreds of thousands of ticks from various villages – and sent them to the Swiss Tropical Institute, where I examined them rapidly and informed him of the results.

DB: Did you know when you were doing this that you were looking for spirochetes in the ticks?

WB: Of course. The agent of tick-borne relapsing fever in Africa was known since the beginning of the century.

DB: So you would receive ticks that Dr. Geigy had gathered in Africa; and your job, first of all, was to examine them and determine whether or not the infectious agent was in the tick. How did you go about doing that?

WB: A very easy and straight forward technique was to take the blood of the tick by amputating part of one of the tick's legs and then put that drop of blood on a microscope slide, and examine it by dark field microscopy. If the tick was infected, a small number of spirochetes could always be detected in the hemolymph or blood of the tick.

DB: You said this was a very easy and straight forward technique. Had this technique been developed prior to your work?

WB: No. It is based on the fact that an infected tick also shows spirochetes in the hemolymph.

DB: But you were the person who figured out how to do that. Is that true?

WB: Yeah. I had to think of a fast technique because Professor Geigy waited for the results that had to be cabled to him as soon as they became available.

DB: Since you developed this technique that you said is easy and straight forward, have other people used it?

WB: Oh, yes, because this procedure was based on the fact that tick-borne agents usually infect the ticks' blood cells. Once spirochetes are detected in the hemolymph (blood cells), one can safely assume that the tick is infected.

DB: Before you began your Ph.D. studies and before you began specifically examining these ticks to see if there were spirochetes in them, had you performed surgery on ticks?

WB: No, no.

DB: That was the technique you had to learn?

WB: That was part of my thesis to determine in what tissues the organism is located and the first thing, of course, I had to do is to familiarize myself with the anatomy and the histology of the tick. So I became a "tick surgeon" during my Ph.D. years.

DB: Not to jump ahead too much, but have you continued during your lifetime to be a tick surgeon?

WB: I guess I have.

DB: Do you have any idea at all of how many ticks you've dissected?

WB: Thousands and thousands and thousands and thousands. No, I have not. To study the distribution and development of pathogens in ticks, I had to examine each tissue very carefully under the microscope.

DB: Just on your own speculation, do you think there's anyone else in the world who has dissected as many ticks as you have?

WB: That's very difficult to say. There are now many schools -- medical entomology departments – and even state health departments, where tick dissection is part of a program to familiarize students with the anatomy of ticks for the purpose of studying the development of a certain microorganism maintained and distributed by ticks.

DB: Have you yourself instructed people how to do this, how to dissect ticks?

WB: Yes, that was part of my teaching. I have taught entomology courses where part of the program was the dissection of ticks and the staining of the tissues for certain pathogens.

DB: The time that you were working on your dissertation, were spirochetes known to cause other diseases besides relapsing fever?

WB: Yes, *leptospirae* were known to cause leptospirosis in animals and humans; and in South Africa, the spirochete *Borrelia theileri* was said to cause mild affliction in cattle, and this spirochete was known to be transmitted by several species of ixodid ticks. Finally there is *Treponema pallidum*, the spirochete that causes syphilis.

DB: During the course of your Ph.D. studies, did you learn how a tick does transmit the agent that causes relapsing fever?

WB: That was one of the main objectives of the thesis, to do a dynamic study and follow the organism from the moment the tick picks it up to the moment it transmits it. And, of course, you had to study the development of the spirochete in the salivary gland tissues because the transmission occurs via saliva of the tick, and that was an important part of the thesis.

DB: And you were the person who discovered that it was transmitted through the saliva of the tick?

WB: No, no, I was not the first one. That had been done by scientists like Dr. Robert Koch, and by British scientists at the turn of the 20th Century in Uganda and Kenya. They were the first to find that spirochetes are not only transmitted by lice but also by ticks.

DB: Did you learn how the spirochete travels to different parts of the victim's body once it enters the body?

WB: You mean the patient?

DB: Yes, the patient.

WB: No, that was not my job. As a medical entomologist, I was interested but I was not an expert in clinical manifestations of the disease. I had no access to patients and only limited access to animals, such as monkeys, guinea pigs and/or rodents.

DB: Tell me what tools you used in order to pursue your studies? Again, when you were working on your Ph.D. thesis. I assume you had a microscope.

WB: Yes, I had a microscope, and a collection of very fine eye-scalpels and Swiss watchmaker forceps. Eye scalpels were used to open the ticks by cutting along the lateral margin. Once the dorsal exoskeleton was removed, the entire internal structure the organs of the tick – became visible and could be removed by means of the fine forceps. Because scalpels and forceps are not always available in the tropics, Dr. Geigy taught us to perform dissections with insect needles – a job that works well on soft-shelled ticks like Ornithodoros moubata, but is very difficult for opening hard-shelled ticks.

DB: And have you done it with a needle?

WB: Oh yes.

DB: Have the tools that you used to dissect a tick changed over the 50 some years that you've been doing that?

WB: No, they're still the same. It's still up to you to train yourself to dissect a tick with any instrument.

DB: And there's a good microscope, of course.

WB: And of course a good microscope, yes.

DB: Dr. Burgdorfer, at what stage in the tick's development is it expected to bite a human being, and again we're talking about the tick that transmits African relapsing fever?

WB: Very likely in the nymphal and adult stages, since the larval stage does not feed.

DB: At what stage does the tick become infected?

WB: Because the larval stage of Ornithodoros moubata is not parasitic, this tick becomes infected as a nymph by feeding on a spirochetemic host. An additional mode for Ornithodoros moubata to acquire spirochetes is by transovarial transmission–which is the passage of spirochetes from an infected female tick via eggs to her progeny.

DB: If the tick becomes infected from an infected victim, what species of victim does it usually pick up the spirochete from?

WB: We still don't know the natural source for these ticks to become infected, although it is commonly assumed that humans are the only source, the only reservoir for the infection of the tick.

DB: So what you're saying is the tick picks up the spirochete from a human and then bites an uninfected human and passes the spirochete to this new victim.

WB: Right.

DB: And how does the victim come in contact with the tick that causes African relapsing fever?

WB: Through a person's exposure to tick-infested soil in poorly constructed quarters. Natives, for instance, slept on bare ground floors from where they were attacked during the night by ticks hiding in the soil.

DB: When you were working on your dissertation in the 1940's, were ticks known to cause other diseases than African relapsing fever?

WB: Oh yes.

DB: What were those diseases?

WB: The first evidence that ticks are involved as vectors of pathogens dates back to the middle of the 19th Century when it was found that "Texas Cattle fever" was caused by the protozoan agent Babesia bigemina, transmitted by the cattle tick Boophilus microplus. At about the same time, Dr. Howard Taylor Ricketts reported that the Rocky Mountain wood tick, Dermacentor andersoni, transmits an agent (later established as a rickettsia) causing Rocky Mountain spotted fever. Other tick-borne diseases include Colorado tick fever and Russian spring summer encephalitis.

DB: Was Russian spring summer encephalitis known about in the 1940's?

WB: Yes.

DB: Do you know if any animals other than humans get African relapsing fever when they're exposed to the spirochete that causes it in human beings?

WB: That is a big question. We don't know the reservoir. We don't know what animals are susceptible to Borrelia duttoni as are humans. We don't know whether there are animals that develop a spirochetemia like humans do.

DB: Dr. Burgdorfer, when you were doing your Ph.D. studies, you said that your ticks were delivered to you by Dr. Geigy who gathered them in Africa. During your studies, did you do any field work to collect any other ticks yourself?

WB: No.

DB: Did Dr. Geigy talk to you at all about gathering ticks in the field?

WB: Well, he told us the methods he used to search for ticks in the crevices and the sand of native huts inhabited by relapsing fever patients.

DB: To the extent that you've gathered ticks yourself, you started to do that after you completed your Ph.D. studies?

WB: Oh yeah. The only tick species I worked with during my Ph.D. studies was the African relapsing fever tick, Ornithodoros moubata.

DB: Do all of those ticks, all of those African relapsing fever ticks, carry the spirochete that causes the disease?

WB: Not all. No, there's only a certain percentage in every given area. Professor Geigy wanted to know what villages, and where in such villages are the highest percentages of infected ticks.

DB: So that is why it was important to him and to you to determine whether or not a tick population was infected.

WB: That's right.

DB: Do you know how relapsing fever is diagnosed?

WB: Yes. The best way to determine whether or not a sick patient has relapsing fever, is to examine his blood during the fever attacks. Relapsing fever is a very characteristic disease, with multiple fever relapses during which the spirochetes circulate in the bloodstream. Therefore, microscopic examination of a patient's blood is the best means of diagnosis.

DB: And have you done that yourself?

WB: Oh yes.

DB: Did you do that when you were preparing your Ph.D. studies?

WB: Yes. The same thing with animals, experimental animals. You want to characterize a given strain of spirochetes, you inject white mice or other animals and you follow daily the infection in the blood by examination of blood smears.

DB: Had that technique been developed by the time that you started your studies?

WB: Oh yes. That's how the British physicians at the turn of last century examined the patients and looked for spirochetes and determined that Ornithodoros moubata is involved in the maintenance and transmission of this organism.

DB: Is relapsing fever a health problem today?

WB: In some African countries you still have a small number of cases every year, but it is no longer the same problem as it had been in the past. Here in the United States, it's certainly no longer a problem. Little is known about Asian countries that occasionally report small outbreaks of the disease. We know that they have louse-borne relapsing fever, but no longer to the same extent as in the last century.

DB: Why is it that it's not the same problem that it used to be? Or do you know that?

WB: I think improved living conditions. Natives in Africa no longer sleep on bare floors; they use carpets, or something like that, that protects them from the direct exposure to ticks.

DB: Is there a cure for relapsing fever, for African relapsing fever?

WB: Yes.

DB: What is that?

WB: Doxycycline. It is very effective, especially when the physician makes a diagnosis based on the spirochete during the first or second relapse. Patients with as many as 14 relapses have been reported.

DB: Can the antibiotic attack the spirochete after 14 relapses?

WB: Yeah.

DB: Is there an effective vaccine against African relapsing fever?

WB: No.

DB: Generally speaking, are there vaccines that are effective for diseases caused by spirochetes?

WB: Well, generally speaking, no, but only recently Lyme disease has been detected as a new disease and a vaccine has already been prepared. Although this vaccine is available on the market, it still is not considered absolutely safe and absolutely effective.

DB: Is there anything in particular about the nature of the spirochetes that makes it difficult to develop a vaccine to protect people against them?

WB: Yes, that is the specificity. Strains of spirochetes from one area differ antigenically from strains in a different area.

DB: As part of your graduate program, did you study any diseases other than African relapsing fever?

WB: Yes, but only in a very limited way. I had the opportunity to join a team of researchers on Q fever, a rickettsial disease in Switzerland.

DB: Could you tell us what a rickettsia is, or what a rickettsial disease is?

WB: *Rickettsiae* are microorganisms just like a spirochete, but differ in their morphology in that they are rod-shaped and short.

DB: Do rickettsiae have flagella like the spirochetes do?

WB: No, *rickettsiae* are not motile. They have no flagella.

DB: Can you by looking at a rickettsia under the microscope and looking at a spirochete under the microscope immediately tell whether the organism is a rickettsia or a spirochete?

WB: Oh yes. As I said spirochetes have a very typical helical morphology, whereas *rickettsiae* are short, rods; sometimes they even look like spherical rods.

DB: So you had quite a bit of experience during your graduate studies identifying these two different organisms. Is that right?

WB: Well, as I said, on a limited basis. My job was to examine arthropods in the areas where Q fever cases did occur, and then to examine these arthropods as to whether they were infected with the Q fever agent, known as Coxiella burnetii. Q fever is in humans a respiratory illness and very, very few cases are known where the tick was responsible for transmitting the organisms.

DB: So, it's an airborne disease?

WB: That's correct.

DB: Can you tell us how the rickettsia that causes Q fever got its name?

WB: How it got its name?

DB: Yes.

WB: Yes I can. The Q stands for “query,” meaning “questions.” Q fever was first described in Australia as a disease of abattoirs (slaughterhouses). It was recognized as a rickettsial disease transmitted by ticks, although it was soon recognized as a disease resulting from inhalation of particulate desiccated rickettsial material.

DB: What about the rickettsia itself, how is that named? Rather than the disease?

WB: You mean *Rickettsia rickettsii*?

DB: No, the *Coxiella burnetii*.

WB: *Coxiella* was named according to Dr. Cox, who was a scientist at Rocky Mountain Laboratory and who, together with Dr. Gordon E. Davis, collected ticks in the Nine Mile area, about 75 miles from here, and isolated an agent that was filterable and proved to be a new agent, for which the name was given honoring Dr. Cox's work on that subject.

DB: So you had heard of Dr. Cox and I take it you had heard of the Rocky Mountain Laboratory when you were a graduate student and studying Q fever. Is that true?

WB: Yes, studying Q fever, and also, of course, relapsing fever because Dr. Gordon E. Davis was the world's best known borreliologist.

DB: Did Dr. Davis have any association with the Rocky Mountain Lab?

WB: Dr. Davis?

DB: Yes.

WB: Oh yes. During the World War he was working on yellow fever in Africa and after the War he started to work at the Rocky Mountain Laboratory on tick-borne relapsing fevers.

DB: Was Q fever a problem disease at the time that you were studying it in Switzerland?

WB: Yes, it was. Q fever epidemics did occur throughout the World War II years in Europe, and probably had to do with the movement of troops in concentrated areas. There were hundreds of cases, especially in Switzerland. It was thought that the disease was introduced from Australia in cattle, sheep and goats.

DB: When did you finish your Ph.D.?

WB: I finished my Ph.D. in 1951.

DB: Was your dissertation published?

WB: Yes. It was published in the Acta Tropica.

DB: Was it published in German?

WB: It was published in German.

DB: What was the title of your dissertation?

WB: The title was--

DB: We're resuming the interview with you. I'm afraid we might not have picked up the whole title of your Ph.D. dissertation. Could you please tell me that?

WB: It's "Analyse des Infektionsverlaufes bei Ornithodorus moubata (Murray) und der naturlichen Uebertragung von Spirochaeta duttoni," which in English means the "Analysis of the Infection Process in Ornithodoros moubata (Murray) and the Natural Transmission of Spirochaeta duttoni."

DB: Was it your goal after you completed your Ph.D. to stay in Switzerland?

WB: Yes, after I had first spent a one-year fellowship at the Rocky Mountain Laboratory under the guidance of Dr. Gordon E. Davis to study tick-borne diseases.

DB: And by that time, in addition to having your Ph.D. dissertation published, had you authored or co-authored any works that were published?

WB: Yes, I had three publications by that time, two in German on relapsing fever, and one publication on Q fever research in Switzerland.

DB: And the Dr. Davis that you were going to work with at the Rocky Mountain Lab, was he the same Dr. Davis who had done pioneering work on Q fever?

WB: That's correct. He was doing pioneering work along with Dr. Cox on the isolation of the first strain of Q fever in the United States, but he was better known for his work on spirochetes and relapsing fever.

DB: And you were familiar with his work through your graduate studies?

WB: That's correct.

DB: How did it come about that you got a fellowship at Rocky Mountain Lab?

WB: Professor Geigy was a close friend to Dr. Parker, the Director of the Rocky Mountain Laboratory. Geigy visited Dr. Parker in 1948, and during his visit Dr. Parker promised him a fellowship for one of his students, a student who would like to expand his studies on tick-borne diseases or on ticks in general.

DB: And you were the student, I take it.

WB: Yes, I was the one -- one of two. One of the graduate students of Professor Geigy received a fellowship to work on DDT campaigns against mosquitoes in Sardinia, and the other could go to the Rocky Mountain Laboratory to study ticks.

DB: And how did you end up being the man who came to the Rocky Mountain Lab instead of Sardinia?

WB: There was a kind of betting among my friend and myself, and I lost. He decided to go to Sardinia; I had to go to Rocky Mountain Lab.

DB: When you say "betting," what kind of betting was this?

WB: We threw up a Swiss franc, heads or tails.

DB: And you lost.

WB: I lost.

DB: When you set out for the Rocky Mountain Lab in Hamilton, Montana, did you know anything about the Lab history of research on tick-borne diseases other than the Q fever research that you had worked on when you were in Switzerland?

WB: Oh yes. I mean, the Rocky Mountain Laboratory was very closely associated with the research of Dr. Ricketts on spotted fever. Dr. Davis was working on tick-borne relapsing fever. Dr. Eklund and his group were working on encephalitis virus, so these studies were known, not in detail, but at least I knew that they were going on. Also studies on tularemia.

DB: These were studies that were accessible to you as a student in Switzerland.

WB: Yes, and there were also some news media. I recall a colored magazine about the Rocky Mountain Laboratory -- I think it was in 1950 or 1949, I'm not sure -- That had pictures of the Laboratory, not only of its investigators, but also of the building, so I knew a little bit when I got here.

DB: Other than those exposures, did you know anything at all about Montana?

WB: No, I knew very little about Montana.

DB: Did Dr. Geigy talk to you at all about Montana?

WB: Well, no, he talked about science, although he enjoyed Montana very much. He used to talk about it, especially about the Glacier Park. He apparently arranged to visit this Park and got some souvenirs there that he showed me.

DB: So he had good feelings about the state?

WB: Oh yes.

DB: Did you know anything at all about Hamilton other than the Rocky Mountain Lab was here?

WB: No, I knew nothing about Hamilton.

DB: And the position that you applied for as the loser of the coin toss was a one year fellowship. Is that true?

WB: That's correct.

DB: Did that position have a title other than a fellowship?

WB: Just a Visiting Fellow.

DB: And were there any special arrangements that had to be made in order for the government here to hire you considering that you weren't an American citizen?

WB: Not at that time.

DB: Is that because it was just a temporary position?

WB: It was a one year fellowship that had to be renewed for a second year, and it was after that that I decided to stay and they had to make arrangements to change my title to a Visiting Scientist so that I could continue working.

DB: When you first came here, did you have any intention or desire to become an American citizen or to remain in the United States permanently?

WB: Initially, no; but when I got permission to stay another year, I began to change my mind.

DB: When you first came here, did you have a job in Switzerland if you were to go back there?

WB: Yes. Professor Geigy promised me upon my return I would start as Assistant Professor at the Swiss Tropical Institute.

DB: You said that Dr. Davis was sort of your sponsor when you came here. Was there anyone else involved in the decision to hire you?

WB: Yes, the Director then was Dr. Carl Larson, who had to approve my application for a second year of the fellowship. The other one was Dr. Philip who was interested in the development of pathogens in tick vectors, exactly the same subject I was interested in, not only on relapsing fever but also on other pathogens such as *rickettsiae*.

DB: You've already said that you had an opportunity to extend your period, your work period here beyond the first year, and you did that you said as a Visiting Scientist?

WB: Right.

DB: What were your duties at Rocky Mountain Lab, both as a Fellow and then as a Visiting Scientist?

WB: There was no difference. I needed my research programs accepted by the peers, like Dr. Larson and Dr. Davis. They were initially on relapsing fever, and then later, on other pathogens such as *rickettsiae*.

DB: Did you still have family living in Switzerland at the time that you first went to the Rocky Mountain Lab?

WB: Yes.

DB: Did you keep in contact with them?

WB: Yes.

DB: You've already mentioned some of the research that was being done at Rocky Mountain Lab on tick-borne diseases when you arrived. Could you tell us, and I know some of this would be repetitious, who was doing that work on tick-borne diseases?

WB: Dr. C. B. Philip and Dr. John Bell were working on various rickettsial problems. Dr. H. Stoenner, Dr. L. Luoto and Dr. R. A. Ormsbee were working on Q Fever; and Dr. C. Eklund was working on Colorado tick fever.

DB: Did you start working with these people or were you working by yourself?

WB: Whenever I could pick up some technology and some knowledge from some of these colleagues, I took advantage of it, especially Dr. Eklund talking a lot about viral diseases and about viral technology, Dr. Philip also. So I didn't only work for myself. I had my own projects, but I always communicated with other staff members.

DB: Did the scientists that worked on tick-borne diseases have a group or a unit name?

WB: Yes. They were called entomologists in a broad sense, and those working with ticks only were referred to as acarologists. Dr. Glen Kohls was the curator of the tick collection at the Rocky Mountain Lab.

DB: When you first came to Rocky Mountain Lab, were there any other foreign scientists here?

WB: Yes, there was another Swiss, hooray! His name was Dr. Edgar Ribi, who came about three months before I did, and was working on tuberculosis and electron microscopy of pathogens such as the agent of tularemia.

DB: Did you become friends with him?

WB: Oh yes.

DB: How large a town was Hamilton when you first came here?

WB: Well, I don't know the exact numbers but I think 2800 people were within the city limits, and maybe about 5,000 people in the immediate surroundings.

DB: Have the immediate surroundings changed since you've been here?

WB: Yes, immediate surrounding is gone. There are more people there than there are within the city limits.

DB: When you first arrived, were any housing arrangements made for you or did anyone assist you with making housing arrangements?

WB: No, all the arrangements were made. I stepped out of the bus and then into the home of Mrs. MacCrackin where I stayed for almost two years.

DB: Who made the arrangements for you to live at Mrs. MacCrackin's house.

WB: Mrs. MacCrackin's house was a house for visitors from all over the world, and I think it was Dr. Gordon Davis who also had a room there, who made the necessary arrangements.

DB: When you say you stepped off the bus, did you arrive in Hamilton via bus?

WB: Via bus, that's correct.

DB: And where did the bus pick you up?

WB: The bus picked me up in Missoula at the bus depot and brought me to Hamilton. That was on the 23rd of December. It was the most beautiful snowstorm that I can remember.

DB: So when you first arrived, you had very positive feelings about the place?

WB: Very positive. Everything was positive at that time. It was Christmas time, a sad time to leave home, but the treatment that I got when I arrived here made up for it.

DB: And how about working at the Lab when you started, did you enjoy that as well as living in the town?

WB: Oh yes. I enjoyed working at the Lab from the first day I was here.

DB: Did you know what the specific focus of your research was going to be when you first arrived here?

WB: Not exactly, because I came here supported by the problems with relapsing fever and tick-borne spirochetosis. I wanted to continue what I did at the Swiss Tropical Institute, where I worked on my thesis. I wanted to use the technologies to expand and work with ticks and spirochetes Dr. Davis was in charge of, but I was told pretty soon after I got here that this type of research is on the way out and that I should think of changing the research program to something else.

DB: Why was research on relapsing fever on the way out?

WB: Because it was no longer justified to support financially a research program based on a handful of relapsing fever cases that occurred every year in the United States.

DB: When you arrived were there any ticks at Rocky Mountain Lab that were infected with relapsing fever?

WB: Oh yes. As I said before, Dr. Davis was the world's best and renowned borreliologist. Why? Because he maintained ten different strains of relapsing fever spirochetes in several species of soft-shelled ticks. His was the only laboratory where you could order soft-shelled ticks or strains of spirochetes for your own studies.

DB: After you were told there's no need for that sort of research, were those ticks kept at the Lab?

WB: Well, they were still kept for a while until Dr. Davis retired in the early 1950's. It was then that I took over and maintained the tick colonies and spirochetal strains for the future.

DB: Are those ticks still there?

WB: No longer, they're now gone.

DB: What research did you do during your first year at Rocky Mountain Lab, especially after you were told that relapsing fever was no longer a point of interest?

WB: Well, I was doing some research on the development of the spotted fever agent, *Rickettsia rickettsii*, in the Rocky Mountain wood tick, *Dermacentor andersoni*. I then was also inspired to get interested in some field work. And I remember well the time when Dr. Smadel, the scientific director, during one of his visits said, "Why don't you go out and try to isolate virulent *Rickettsia rickettsii*. Even though this laboratory has done excellent work for years and years there never has been an isolation of the agent of spotted fever in the laboratory. Why don't you go out and fill this still-empty page with some observations from the field." Following his advice, I changed into studying the natural history and ecology of the Rocky Mountain spotted fever agent, *Ricke ttsia rickettsii*.

DB: Had you ever done field work before?

WB: Well, limited on Q fever in Switzerland, where I tried to find a source of the Q fever rickettsia in the immediate environment of patients. But otherwise not. I didn't have any opportunity to do some field studies during my graduate studies.

DB: Were there any wood ticks being kept at the Lab at this time?

WB: Yes.

DB: Who had gathered those?

WB: Well, Dr. Kohls and Dr. C. B. Philip maintained colonies of *Dermacentor andersoni* from various locations in the Bitterroot. Dr. Kohls was in charge of the tick museum, and he as well as Dr. Philip also maintained some live tick colonies.

DB: So once you started to do field work, I take it you gathered your own wood ticks.

WB: Yes.

DB: And was that in Hamilton or right around Hamilton?

WB: Yes. And that is where I applied the hemolymph test for the first time in an effort to find out where in the valley do we have high percentages of infected ticks.

DB: And that's the test that you--the technique actually--that you developed and described doing your research for your Ph.D. thesis.

WB: That's right.

DB: How did you go about gathering the ticks in and around Hamilton?

WB: In the early spring shortly after the snow had melted, we went into every canyon on the west side of the Bitterroot Valley and also into some drainages in the Sapphire Mountains, and collected hundreds of ticks by flagging vegetation. The ticks were then brought to the laboratory for testing. Those that were positive for *rickettsiae* were placed on laboratory animals, mostly guinea pigs and rabbits, and were raised to establish ovarially infected new tick generations.

DB: Where did you keep the guinea pigs and rabbits?

WB: In animal buildings.

DB: Were the animal buildings already built when you were there?

WB: Yes.

DB: Do you keep any other mammals for the maintenance of the ticks besides guinea pigs and rabbits?

WB: Oh yes. We used rodent species, squirrels indigenous to the Bitterroot.

DB: What sort of tools did you have in your lab at the Rocky Mountain Lab.

WB: Besides microscopes, every tool necessary for successful maintenance of tick colonies were readily available, and included holding cages for small animals, feeding tubs and safety pans filled with water to prevent the escape of ticks. Any tools needed for this work.

DB: Were they the same tools that you used in Switzerland when you were doing your Ph.D. work?

WB: No, because in Switzerland I didn't have access to laboratory animals, except mice. Here we had access to larger animals.

DB: What about the tools for dissecting the ticks? What did you use?

WB: The same ones I used in Switzerland during my thesis, watchmaker forceps and eye scalpels.

DB: And were the scalpels and forceps Swiss-made?

WB: Yeah.

DB: When did the opportunity to extend your one year fellowship first come up? Was that during the middle of the first year, or when was it? When did you learn that it might be possible to extend your first year here?

WB: After about nine months, I realized that there was not enough time to finish the experiments I started initially. Dr. Larson assured me that he could get a one-year extension of my fellowship.

DB: Did you continue then to do the same work you had been doing during the first year?

WB: That's correct.

DB: And did you interact with the same people at the Lab?

WB: That's correct.

DB: At that time did you want to become an American citizen?

WB: Yes, the latter part of the second year.

DB: And how long would that have taken in the ordinary course of events?

WB: I recall seven years. You have to have seven years after you declare the intention of becoming an American citizen.

DB: How long did it take you to become an American citizen?

WB: It took me four years. Let me see, let me make sure here. In 1953, it took me four years.

DB: And what event occurred that allowed you to become a citizen more quickly than the usual seven years?

WB: I got married. Fell in love with a secretary here at the Laboratory and then got married. Three years later, I was able to apply for citizenship.

DB: And what was the name of the lady that you fell in love with and married?

WB: Gertrude Dale See.

DB: And is she the same lady you're married to now?

WB: That's correct.

DB: You said she was a secretary. Was she a secretary at the Lab?

WB: She was a secretary at the Laboratory in the Director's office. She was also a technician for Dr. Harget, preparing yellow fever vaccine.

DB: And what was it about Dale that helped establish a relationship between the two of you?

WB: Dale was speaking French and I was looking forward to periodically have a French conversation.

DB: So you spoke French?

WB: I spoke French and she spoke French, so we were able to at least converse.

DB: And she also spoke English, of course.

WB: She was a Bitter rooter, born in the Bitterroot. In fact, she knew more about the history of the Bitterroot than anyone I ever met.

DB: When did you marry Dale?

WB: I married Dale in 1953.

DB: And at that time did you move out of Mrs. MacCrackin's house?

WB: Yes, I did.

DB: How close was Mrs. MacCrackin's house to the Lab?

WB: Only four blocks.

DB: And after you married Dale, where did you live?

WB: Well, we first lived in the same house where Dale was born. We shared the home with her mother. That house was close to the Lab. And when the kids were born, we moved to a new home, also close to the Laboratory.

DB: So the new house was also right in town, close to the Lab?

WB: Yeah. It was in the Edgemont Addition, south Third Street.

DB: I know that your real expertise and accomplishments have all been related to tick-borne diseases and most prominently related to Lyme disease. But before talking about that, I wonder if there was any research you did at the Rocky Mountain Lab that didn't specifically deal with ticks or disease causing organisms that were carried by ticks.

WB: No, I didn't. Whatever I did ticks were involved. However, there were three years or four years I was working on other problems.

DB: And what were these other problems?

WB: They concerned the development of techniques that would allow for the rapid diagnosis and identification of pathogens in ticks.

DB: What was the purpose of that research?

WB: The purpose of that research had a defense character, in that it called for development of techniques allowing rapid identification of pathogens that might be used against the United States.

DB: And by defense do you mean military defense?

WB: Yes.

DB: And what years did you do the defense-related work?

WB: 1954 to 1957.

DB: And was that all done at the Rocky Mountain Lab?

WB: It was all done at the Rocky Mountain Lab in my laboratory, although I was under the supervision and guidance of Dr. C. B. Philip. He was in charge of that project.

DB: Did you publish any of the defense-related work that you did?

WB: No.

DB: And why was that?

WB: It was classified.

DB: Did you record the results of the other research that you did during the 1950's, or keep logs of any sort?

WB: Yes.

DB: And do those research logs and records still exist?

WB: The majority still exist; some were tossed out and are no longer in existence, except the final results as summarized in quarterly and annual reports, as well as those published in the scientific literature.

DB: Do you know when the logs were thrown out?

WB: No, I don't have any idea.

DB: Was that your decision or an administrative decision?

WB: I think that was an administrative decision, because the logs were kept for a long, long period of time, for years and years, and suddenly they were no longer considered important.

DB: I know that you've talked about this already, but I'm wondering if you could summarize what organisms and diseases you researched at Rocky Mountain Lab prior to 1981.

WB: The tick-borne pathogens and the diseases caused by them included spirochetes, the cause of relapsing fever; *rickettsiae*, the cause of Rocky Mountain spotted fever and related ailments; and Colorado tick fever virus, the cause of Colorado tick fever. In addition, I worked on the survival in, and the transmission by fleas of the plague organism, *Yersinia pestis*, and on the susceptibility of mosquitoes to yellow fever virus. Also, I worked on the development of California encephalitis virus in mosquitoes and on the development of Francisella tularensis, the agent of tularemia, in ticks.

DB: You undertook quite a bit of research it sounds like.

WB: Yes, and the yellow fever virus studies required work with rhesus monkeys.

DB: Were the monkeys kept at the Rocky Mountain Lab?

WB: Correct.

DB: Were there animal houses for them?

WB: Correct. Buildings.

DB: Were you publishing during this time. Again, by "this time" I'm talking about up until 1980 or 1981. Were you publishing the results of your research?

WB: I think there were--from 1960 to 1980 did you say?

DB: Just up until--from the time you started at the Lab until 1981, were you publishing?

WB: 77 publications.

DB: So you were a pretty prolific writer?

WB: You had to be.

DB: When you say you "had to be," why is that?

WB: Dr. Larson always said you do a good job here if you have at least three publications per year. Anything below means, "Get going."

DB: So you published at least three articles a year? Did you publish all of these articles in English?

WB: Most of them in English. One was in French, and I don't know, two or three were in German.

DB: Did you have trouble writing articles in English when you first started doing that?

WB: English problems.

DB: How did you overcome those problems?

WB: By learning English or trying to learn English. The American way of reporting, writing scientific articles, was completely different than the European way. The Europeans like to expand and to put some color into their publications, whereas the Americans are cut and dry.

DB: Did your colleagues help you write the American style?

WB: Yes. I think I still have the first manuscript I submitted to my colleagues and they took every word apart.

DB: And so did you put it back together the way that made it a successful article?

WB: Yeah.

DB: And I take it this got easier and easier the more you did it?

WB: Of course. The more you are writing, the more experience you get. I often refer to the "red line" running through the subject you are writing about. Stick to the red line, you will produce a good paper. Deviate from it, and you will lose the reader's attention.

DB: In addition to the articles that you've had published and the records that you made and the logs you made of your work, that is the logs that you did early on, did you maintain any records of your research effort from the 1960's and 70's through 1980?

WB: Oh yes.

DB: Do you still have any of those records?

WB: Yes.

DB: Do you keep them at the Lab?

WB: Yes. They are in my files at the Laboratory.

DB: Do you know what ticks live in Montana? How many ticks you think live in Montana?

WB: No, I don't, and I don't think anyone else does. We know the ticks involved in maintaining and distributing pathogens, such as the wood and rabbit ticks. A thorough study of the ticks of Montana, to the best of my knowledge, has not been made.

DB: So that's work that needs to be done or could be done.

WB: It could be done. I doubt that it would get wide support, unless a new disease emerges with completely different species of ticks involved.

DB: When you began your work at Rocky Mountain Lab, had the organisms that cause Colorado tick fever and Rocky Mountain tick fever, as well as relapsing fever, all been identified?

WB: Yes, they had been identified, let's say representatives of these agents had been identified, but thorough studies of either of those agents had only been done during recent years. The natural history of spotted fever had been initially worked out by Dr. Ricketts at the turn of the century. But strain isolations and isolations of different *rickettsiae* and different viruses and so on had not been done in those days.

DB: Could these organisms be cultured when you started work here?

Dr. Yes.

DB: You've already told us that the organism that causes Rocky Mountain spotted fever and *Rickettsia rickettsii*, and you said that is usually carried by the wood tick. Is that right?

WB: Yeah, the Rocky Mountain wood tick, *Dermacentor andersoni*.

DB: Are all wood ticks infected with *rickettsiae*?

WB: No. Only about 2 to 3 percent of the ticks in the Bitterroot Valley on the west side of the river are infected with virulent strains of spotted fever *rickett siae*. There are 15 or even higher, 20 percent of ticks that maintain *rickettsiae* or *rickettsial* agents that are not virulent for humans, they are non-pathogenic.

DB: Are there ticks other than the wood tick or is there any other known carriers of *Rickettsia rickettsii*?

WB: Yes, there are different species of ticks, like the rabbit tick, *Haemaphysaiis leporispalustris*, that are involved in maintaining rickettsial strains in nature throughout the United States.

DB: You indicated that when you were determining whether or not wood ticks were infected, you used some of the same techniques and procedures, or basically the same techniques and procedures that you had used in Switzerland when you were examining the ticks from Africa. Is that right?

WB: Yes.

DB: And is that the same technique you would use now if I were to give you a tick and ask you if it was infected?

WB: The only one, and the most dependable one.

DB: And is that the same technique that somebody else would use if they were capable of determining whether a tick was infected?

WB: Yes. If you have a tick on your head and give me the tick in half an hour I can tell you whether or not you have to watch out for clinical manifestations that could be spotted fever or something else.

DB: And in fact many people in Hamilton do end up with a tick on their head and do want to know if it's infected. Isn't that true?

WB: It certainly is. In most instances the ticks I examined off people were negative for *rickettsiae*. When people were bitten by positive infected ticks, I always referred the victims to their physicians for observation and treatment. Throughout my career, I emphasized that there is no such thing as a "normal tick" and that a negative test does not rule out the presence of undetectable pathogens such as viral agents. Sometimes the ticks I examined were dead ticks that people had crushed in efforts to get rid of them.

DB: And that makes it harder for you to determine whether there's a viral, or a detectable agent in it?

WB: That's right.

DB: How much work had you done before 1981 to determine whether ticks or tick populations were infected with agents that cause Rocky Mountain spotted fever?

WB: A lot of work. In those years, we had expanded our survey research and educational programs for people to other areas such as Mississippi, Tennessee, South Carolina, Ohio, and Connecticut. These are states reporting cases of spotted fever every year. And we initiated educational programs about ticks – how to prevent them and how to safely remove them once attached.

DB: Continuing the interview with Dr. Burgdorfer on July 13, 2001 in Hamilton. Dr. Burgdorfer, I know we've talked about this already a little bit, but could you tell us or tell us again, whether the organisms that cause Rocky Mountain spotted fever and the organisms that cause relapsing fever, are similar in any way, just to look at them.

WB: Just to look at them, the answer is no. Rickettsia are short rods bacteria. The spirochetes are also bacteria but they are coiled, long microorganisms, and there is no doubt that anyone can differentiate these organisms based on their morphology alone.

DB: Obviously not anyone can tell the difference, but you certainly can. Is that true?

WB: Yes.

DB: And by 1981, I take it just from what you've told us during this interview, you had looked at an awful lot of spirochetes and you had looked at an awful lot of *rickettsiae.* Is that true?

WB: Correct.

DB: In the case of the ticks that you studied up until 1981, had your research contributed to cures or prevention of tick-borne diseases, and again I realize that we've touched on that already, but I'd like you just to talk about whether or not, first of all, your research has contributed to cures for any tick-borne diseases?

WB: Not exactly for cures, but certainly for the education of the general public and of physicians in an area in which Rocky Mountain spotted fever is prevalent. As I mentioned, we did tick surveys in various states, Mississippi, Tennessee, South Carolina, Ohio and Connecticut, to identify the areas with a high incidence, not only of spotted fever, but also of infected ticks. And along with these tick surveys went educational activities to educate the general public about ticks and about the prevention of tick bites and prevention of disease.

DB: So do you consider education the main preventive mechanism for tick-borne diseases?

WB: That's correct. The education is the best means of preventing a tick-borne disease. Once you know how ticks look like, you recognize them right away and can remove them properly; and then the chances of getting sick are not as great.

DB: Dr. Burgdorfer, what sort of work schedule did you have at Rocky Mountain Lab when you first came there?

WB: When I first came it was from 8:00 o'clock in the morning until 12:00, and from 1:00 o'clock until 5:00. Then they changed that from 8:30 to 12:00, and from 12:30 until 4:30.

DB: Did you ever work beyond that schedule?

WB: Probably all the time.

DB: But those were the official hours?

WB: Yeah.

DB: When were you actually at the Lab?

WB: I usually went to the Lab between 8:00 and 9:00 o'clock in the morning and worked there until noon, but then in the afternoon I started around 1:00, 1:30 and worked many, many, many days until midnight, just depending on the amount of work that needed to be done.

DB: It sounds like you were especially interested and intrigued by the work you were doing. Is that a fair statement?

WB: Yes, and once the tick material was sent to us, we had to work it up immediately to prevent a lot of those ticks from dying. Many times eight hours a day was just not enough to take care of all the material, because in many instances physicians who did send in ticks for examination wanted to know the results and I'll put that into quotes, "often before we got the ticks."

DB: And it's something you couldn't just let lie, I take it.

WB: That's right.

DB: Were there any changes at the Rocky Mountain Lab prior to 1981 that affected your work there in any way?

WB: No, there were no changes as yet, although by that time I began to realize that molecular biology and the new sophisticated molecular techniques that became available, were completely different than the laboratory techniques we used in determining infection in ticks or the development of the pathogens in ticks. And these changes, especially in genetics and molecular approaches to the problems, some of us, myself included, were not schooled, we were not educated in using these approaches.

DB: And going back to your education and schooling, specifically with Dr. Geigy, did you maintain contact with Dr. Geigy after you became an American and were fully established at the Rocky Mountain Lab?

WB: Yes, certainly I did. I kept him informed of what I was doing and how the work was coming along. I would say two, three letters, detailed reports, every year.

DB: And did he write back to you?

WB: Yes, yes he did, and many times he had some suggestions as to the research direction in which we should go.

DB: Were these good suggestions? Were they pertinent to what you were doing?

WB: Yes, because Professor Geigy, as I mentioned before, was not only a professor in zoology, but he also loved the work on tick-borne diseases, especially African diseases, not only tick-borne, arthropod-borne in general. He was interested in my research program.

DB: So you maintained a pretty close relationship with Dr. Geigy.

WB: Yes, very close.

DB: How long did you maintain that relationship?

WB: Until Professor Geigy retired and could no longer maintain the connection with some of his students. Maybe one letter a year was just about all you got from him, or cards telling you that he enjoys skiing in Switzerland and that he has retired and is no longer up to par with the scientific advances.

DB: Do you remember how old he was when he retired?

WB: No, I don't exactly remember, but his students, including myself, honored him at his 80th birthday with a symposium on spirochetes and tropical diseases. He enjoyed his retirement in Switzerland until he died.

DB: Do you remember what year he died?

WB: It was about five years ago. He was 94 years old.

DB: So did you maintain some contact with him until his death?

WB: Let's say until about two or three years before his death.

DB: Have you kept the letters that Dr. Geigy wrote to you during this time period?

WB: Yes.

DB: And where do you keep those?

WB: I keep them in my personal files.

DB: Getting into your discovery of the spirochete that causes Lyme disease, first of all, would you say that this is the work that you were most famous for or most known for?

WB: Right now probably this is true. Before that, I had a reputation as, let's say, I think I mentioned it once before, "tick surgeon," meaning that whenever when I got any ticks in for examination to see whether they were infected, I always did a thorough sectioning.

DB: And again I think you said there probably isn't anyone else in the world who has dissected as many ticks as you. Is that probably so?

WB: I think that's a safe statement to make, although there are several research laboratories, especially associated with state health departments in this country where tick examination, the way I used to do it, is also being practiced, because it's the state health officers who emphasize getting tick material for examination, especially where human patients are concerned.

DB: So those health officers are using the same techniques that you used.

WB: Yeah, they have technicians that are following very similar steps, although I have to emphasize that today, of course, you've got PCR and other molecular techniques that are much faster and just as exact as what we used to do with the ordinary microscope and ordinary techniques.

DB: And those are the same techniques that you were using when you were a graduate student in Basel.

WB: Correct.

DB: Going ahead to your work with Lyme disease, can you remember when you first examined eastern deer ticks?

WB: Yes, I can, but I have to mention the background of that examination. It goes back to the year 1977 when I started to collaborate with Dr. Benach from the New York State Health Department. The objectives were to recover virulent strains of *Rickettsia rickettsii* from the dog tick, *Dermacentor variabilis* , which is the vector of spotted fever along the Atlantic seaboard. We wanted to get virulent strains of these agents from the immediate environment of patients. In the years '71 to '76 there were 124 spotted fever cases with eight deaths in New York State. So we thought that collections of ticks from the immediate surroundings of these patients would provide us with virulent strains of *Rickettsia rickettsii*. Although we did find six percent of the ticks infected with *rickettsiae*, none was of the virulent type. They all were found to be *Rickettsia montana*, a non-virulent rickettsial species that does not produce human disease. So we started to speculate maybe there were other ticks in that area that were responsible for maintaining and distributing spotted fever *ri ckettsiae*. The only tick we could think of, a tick that appears abundantly in those areas, was the eastern deer tick, which at that time was called *Ixodes scapularis*, but the name of which was changed, so that it became known as *Ixodes dammini*. The tick is now again recognized as *Ixodes scapularis*, since the two species, *dammini* and *scapularis* have been found to be co-specific, or one and the same. The first pool of ticks submitted for examination arrived in 1979.

DB: When you say he submitted the first pool of ticks for examination, does that mean he sent them to Hamilton for you to examine?

WB: That's correct. He and his co-workers collected the ticks off vegetation in the neighborhood of patients, and then he forwarded them to me for examination by hemolymph testing. We did find *rickettsiae* in high percentages, of ticks, but they all were of the non-virulent *Rickettsia montana* type.

DB: Prior to receiving the pool of ticks from Dr. Benach, had you examined eastern deer ticks?

WB: No.

DB: And just to avoid confusion later, in your publications when you talk about *Ixodes dammini*, you're talking about the *Ixodes scapularis*.

WB: Scapularis.

DB: And the name is just changed back and forth.

WB: The name changed back and forth. The geneticists determined that genetically these two ticks once thought to be two different species are one and the same. The name *Ixodes scapularis* now has priority.

DB: And again, you were examining these ixodes ticks for a virulent *rickettsiae*.

WB: That's right.

DB: And what parts of the ticks were you examining, in the late 70's and I guess the early 80's?

WB: First of all the hemolymph, the blood of the tick. As I described and said before, hemolymph tests consist of obtaining a small droplet of the hemolymph of a tick by amputating one or more legs of the tick and then smearing this blood on a slide and staining it, for examination for *rickettsiae*.

DB: About how many ticks did Dr. Benach send you, or do you remember?

WB: Gosh, I don't remember that because he sent hundreds of them, or possibly even thousands.

DB: And what part of New York were these ticks from?

WB: They were from Shelter Island and from Long Island.

DB: Was Lyme disease a problem in Shelter Island at that time?

WB: It's one of the areas where Lyme disease was, and still is, a major health problem.

DB: You hadn't been asked to examine the ticks to make any determination about Lyme disease?

WB: No, no.

DB: It was all for spotted fever.

WB: That was all spotted fever and, as I said, Long Island was a good spot for spotted fever.

DB: Did you know much about Lyme disease at that time, and again by that time I'm referring to the very late 70's and the beginning of 1980's.

WB: I knew from the literature about the disease in old Lyme, Connecticut, but I didn't have an interest in it. I knew that the agent causing Lyme arthritis, as the disease was called at first, was not known.

DB: When was the eastern deer tick discovered?

WB: Oh gee, there are records in the literature that this tick was seen in the early 1700s and was a considered a nasty parasite for the pioneering people.

DB: And from what you've already told us, it sounds like by 1981 it was not known that the eastern deer tick was the carrier of the agent they called Lyme disease.

WB: That's correct. It was not known. It was suspected by the people in Connecticut that ticks may be involved in maintaining and distributing whatever causes the disease.

DB: And did anyone know what it was that caused the disease? Again the disease being what was called Lyme arthritis.

WB: No. Not at that time.

DB: Were there any theories before 1981 about the actual agent that causes Lyme disease?

WB: Not in this country. In Europe, yes. In Europe, what is now known as Lyme disease was referred to as *erythema migrans*, which is a period of manifestation of the disease in form of lesions appearing on the skin. In 1909, the Swedish physician Dr. Arvid Afzelius presented to the Dermatological Society in Stockholm, Sweden, an annular skin lesion at the site of a previous bite by the sheep tick, *Ixodes ricinus* – the most common tick in Europe. Because of the characteristically expanding or "migrating" ring on the skin surface, Afzelius named the disorder, *Erythema migrans*. It was also called *Erythema chronicum migrans,* or ECM because in some patients, the erythema lasted as long as six months. The cause of ECM was unknown although the sheep tick was suspected as the vector of whatever caused the disease.

DB: When was this theory developed?

WB: As early as 1909, there were publications on ECM.

DB: And had you read those publications by 1981?

WB: Well, by 1981 I knew of them, particularly of a paper by Dr. Hellstrom of the Karolinska Institute in Sweden. In 1949, Dr. Hellstrom presented a talk entitled, "ECM Afzelius with Meningitis," at the 43rd annual meeting of the Southern Medical Association in Cincinnati. He not only reviewed the number of cases in which after tick bites, both *Erythema migrans* and subsequent meningeal symptoms occurred – he also reported on the successful administration of penicillin in the treatment of ECM. He also presented his thoughts on the still unsolved etiology of ECM. Unfortunately, no one followed up on this work.

DB: There was no follow up on the Swedish scientist?

WB: There was no follow up on it.

DB: And was there any suggestion at that time that the agent was a spirochete?

WB: Dr. Hellstrom pointed out that circular erythemas subsiding in the center and advancing peripherally may occur not infrequently in association with spirochetal or other infections. He concluded that "it seems reasonable to raise the question of whether ticks are carriers of spirochetes with allergizing – and immunizing – properties." Unfortunately no one followed up on his speculations.

DB: So, again there was no scientific follow up on that suggestion?

WB: There was no follow up at all by anyone.

DB: And again, it sounds like prior to 1981 you weren't giving any serious thought or you weren't doing any research on Lyme disease.

WB: No. I helped and I informed Dr. Steere and his medical entomologist, Dr. Main, about techniques involved in determining whether or not a pathogen is present in the tick population in Connecticut.

DB: Could you just briefly explain who Dr. Steere was?

WB: Dr. Steere was the health officer who was asked to investigate the strange cases of rheumatoid arthritis occurring in Connecticut.

DB: So he thought that the disease might be transmitted by a tick and he wanted to know how to examine ticks?

WB: That's correct.

DB: And did you tell him how to examine a tick?

WB: Of course. We had two two-hour-long discussions with step by step instructions.

DB: So you gave them detailed instructions on how to dissect ticks?

WB: Yes.

DB: Going back to the ticks that Dr. Benach sent you from Shelter Island, when you were dissecting those ticks you were looking for the bacteria that causes Rocky Mountain spotted fever, and you said you did find some rickettsiae, is that right?

WB: Yes.

DB: That it wasn't virulent for the most part?

WB: Yes.

DB: And were you examining these ticks the way that you examined ticks in the past?

WB: Correct. We first subjected them to the hemolymph test to determine whether they were infected with *rickettsiae*. That was our prime objective.

DB: And you told us you found rickettsiae that weren't virulent. Did you find anything else in these ticks?

WB: Yes.

DB: And what was that?

WB: There were two female ticks in whose hemolymph I noticed the presence of microfilaria – the young stages of a nematode – similar to microfilaria I had seen before, in the hemolymph of the European sheep tick, *Ixodes ricinus*. I now wanted to know whether these microfilaria occurred not only in the tick's blood – or hemolymph – but also in other tissues. I dissected both ticks and prepared tissue smears from each organ for microscopic examination. There were no additional microfilaria, but instead I detected in the midgut of both ticks large numbers of faintly stained, slender, snake-like micro-organisms that I recognized right away as spirochetes.

DB: Before you found the spirochete it sounds like this examination was sort of a bust. You looked in the blood for virulent *rickettsiae*, you didn't find that. Then you found a nematode and you did further surgery and examination to find more nematodes in the tissue and you didn't find that.

WB: Right.

DB: And then you did find what was a spirochete. And in what part of the tick did you find the spirochete?

WB: It was only in the mid gut.

DB: In the midgut.

WB: That's right, in the digestive system, because it's part of it.

DB: And did you at first find just one spirochete or several?

WB: Several. Of course, there were clumps of them. The original photograph of what I saw shows about three and four individual organisms; another photograph shows clumps of spirochetes.

DB: And by the photographs, you're talking about photographs that you--

WB: That I took.

DB: After you found them, did you recognize these clumps of organisms immediately?

WB: Yes. Once my eyes focused on these long snake-like organisms, I recognized what I had seen a million times before: spirochetes. Right away I also speculated that this may be what the Europeans are talking about or speculating about. Next, I wanted to make sure that it was a spirochete; so I took a little drop of the midgut, put it under the dark field to see whether the organisms were alive and whether they showed the typical movement of spirochetes – a characteristic rotational and translational movement.

DB: Again, you had a lot of experience looking at spirochetes, starting with your graduate work. Is that right?

WB: Yes.

DB: And you were certain that it was a spirochete. Is that right?

WB: Yeah. Once I put it under the dark field, then I saw the movement, the activity of the organism—characterized by translational and rotational movement.

DB: You were certain?

WB: Yeah.

DB: Was there anyone at Rocky Mountain Lab who was able to isolate and culture the spirochete?

WB: At the time this discovery was made, there was Dr. Alan Barbour and the Director, Dr. Stoenner, who were working on the antigens of the relapsing fever spirochete, *Borrelia hermsii,* and were culturing this spirochete in Kelly's medium which is a special medium that many years ago was invented by Dr. Kelly and used for successful culturing of *Borrelia hermsii*, the causative agent of tick-borne relapsing fever in northwestern United States.

DB: So it was fortunate then that there were people at the Lab who at that time were culturing spirochetes.

WB: That's right, and maintaining spirochetes in culture.

DB: Has Dr. Barbour continued to work on Lyme disease?

WB: Oh yes. Yes.

DB: And did Dr. Stoenner do any further work on Lyme disease?

WB: Not on Lyme disease, no. He finished his studies on the diversity of antigens in *Borrelia hermsii.*

DB: What year was this that you actually saw the spirochete in the midgut of the Ixodes tick?

WB: 1981.

DB: And since Dr. Stoenner and Dr. Barbour were working on spirochetes, did you ask them if they could culture this spirochete?

WB: Yes. I showed the organism first to Dr. Barbour. Dr. Stoenner was away attending a conference or meeting, and Dr. Barbour just came back from a meeting, saying that Dr. Steere had found the agent of Lyme disease, and he showed me a photograph.

DB: And what was the photograph that he showed you?

WB: The photograph was a leptospira, but not a Borrelia.

DB: Could you tell some of the characteristics that make it recognizable as different from the *Borrelia*?

WB: *Leptospirae* are bent or hooked; they have hooks on both ends. They look like a typical spirochete, except at both ends they have one or two coilers.

DB: And the *Borrelia* does not?

WB: The *Borrelia* don't have that, no.

DB: So you knew that it was different from what you had found in the midgut of the Shelter Island tick?.

WB: Yeah, I told Dr. Barbour, "What you're showing me here is a leptospira and if Dr. Steere says this is the agent of Lyme disease, he is wrong." Of interest is the fact that Dr. Steere isolated his *leptospira* from a Lyme disease patient.

DB: But you knew it wasn't the same critter that you had discovered?

WB: That's right.

DB: Dr. Barbour and Dr. Stoenner then went about culturing your spirochete. Is that right?

WB: Dr. Barbour did. I suggested and invited him to cultivate or to try to cultivate and isolate this spirochete. I gave him three infected ticks from which he succeeded in isolating and culturing the organism.

DB: What further work did you or you and Dr. Barbour do to determine whether or not the spirochete that you discovered was the cause of Lyme disease?

WB: Within hours after I detected this organism, I asked Dr. Benach to approach Dr. Grunwaldt – a physician on Shelter Island who had in his refrigerator numerous sera from acute and reconvalescent Lyme disease patients – to send me some for indirect fluorescent antibody testing. When the tests were positive, we knew we were dealing with the causative agent of Lyme disease.

DB: You said you did this within hours, it sounds like you were quite excited about this discovery.

WB: Yes, quite excited.

DB: And was Dr. Barbour excited?

WB: Yes, of course he was, because he also knew, as I did at that time, that everyone is looking for the agent of Lyme disease.

DB: Why was everyone looking for the agent that caused Lyme disease in the '80s?

WB: Initially, Dr. Steere described the disease as a new form of arthritis. He soon learned that many patients suffered not only of arthritis, but also of disorders affecting the skin, muscular, cardiac, and nervous systems. Thus, he changed the name from Lyme arthritis to Lyme disease.

DB: Are these symptoms that you're talking about painful to the patient?

WB: Yes, some are.

DB: So it was a public health problem at that time.

WB: Yeah, oh yeah, it was. Of course all of these forms described by Dr. Steere and his colleagues, already were in the literature in Europe because they were described there also as individual diseases because no one knew that the spirochete was the cause of all these manifestations.

DB: When you became convinced that the spirochete was the agent that causes Lyme disease after you and Dr. Barbour and Dr. Benach had talked about it, did you write up the results of your discovery?

WB: Yes, of course.

DB: And were the results published?

WB: The results are published in Science.`

DB: And what year was that?

WB: That was in 1982.

DB: How soon after discovering the spirochete was the article completed?

WB: I found the spirochete in November 1981, and we completed the article for *Science* in the spring of 1982.

DB: The title of that article is "Lyme Disease, a Tick Borne Spirochetosis?" There's a question mark after it. Why did you put that as a question?

WB: Because we wanted to make absolutely certain that the organism found could be associated with the claimed manifestations of Lyme disease. That had not yet been confirmed for all of the symptoms that had been reported, not only in this country, but also in Europe, where the first clinical manifestation had been recognized as early as 1883, almost 27 years before Dr. Afzelius described *erythema migrans* again as part of the disease pattern that now is known as Lyme disease.

DB: Back in 1981 when you looked at that spirochete, were you as well versed in this history of this disease as you are now?

WB: Yeah, of course. There was something very unusual about this whole thing, and that was to find spirochetes associated with the gut, within the digestive system of the tick, because spirochete in relapsing fever, I think I mentioned that before, once the tick is infected after certain time the spirochetes leave the gut and they go into the tissues. This spirochete stays in the mid gut and then during the tick's feeding as we learned later, passes through the gut wall into the hemolymph of the tick and from there on into the salivary gland from where it is transmitted during the feeding of the tick – an infection pattern different from that found in *Ornithodoros moubata* for *Borrelia duttonii*.

DB: If you hadn't been familiar with spirochetes from your study of many years, beginning with your graduate studies, is it possible you wouldn't have recognized the spirochete in the midgut of the eastern deer tick quite so quickly?

WB: Yes, that's true.

DB: Going back to the article that you published, you're not the only author listed on the article, and you've told us what role Dr. Barbour played in this discovery. Can you tell us what role some of the other authors played?

WB: Dr. Benach, of course, for sending me the ticks, and sort of having the same speculation, we decided let's concentrate on the deer tick to see whether or not they are carrying the rickettsial agent.

DB: So if he hadn't done that, of course, you would never have been cutting open the tick.

WB: We don't have any source of that in Montana. They have to be collected and shipped in. And the other one was Fred Hayes. He is a laboratory technician and also a medical electron microscopy specialist. He is responsible for the beautiful pictures we published of the spirochete in the midgut of the tick.

DB: Is Dr. Hayes still at the Rocky Mountain Labs?

WB: He is not a doctor, he is a technician in the laboratories' electron microscopy unit headed by Dr. Garon.

DB: Is Dr. Benach still in New York?

WB: Yes, he is still associated with the New York State Health Department.

DB: Do you maintain contact with him?

WB: Yes.

DB: And then Dr. Grunwaldt?

WB: Dr. Grunwaldt is the physician on Shelter Island who followed hundreds and hundreds of patients and collected the sera and maintained the serum bank so once Dr. Benach got my phone call, all he had to do is call Dr. Grunwaldt on Shelter Island to get the sera we used to identify the spirochetes.

DB: So you thought he deserved credit in the article for that.

WB: Oh yeah. Then there was Dr. Davis. I worked with him on ticks from Wisconsin and we evaluated sera from patients who did have Lyme disorders. I felt he also should be credited for his collaboration.

DB: Were all these people as excited as you were about it?

WB: Probably not. Jorge Benach was, yeah, and so was Fred Hayes, because Fred worked very closely with me also on the ultra-structure of ricksettsial agents. We had a very good working relationship.

DB: Again, your article title had a question mark after it. What work had to be done after you published that article to determine that the spirochete you discovered was the actual agent that causes Lyme disease.

WB: Isolation from patients. Additional isolation and identification from ticks.

DB: And did you follow through with that?

WB: Oh yeah. That was done in my laboratory. I was responsible for that work.

DB: You wanted to cinch this.

WB: Yeah, I wanted to be absolutely certain

DB: Was the spirochete that you discovered a new spirochete as far as you could tell?

WB: Yes.

DB: And one thing that made it new to you, of course, is that it was a Borrelia dwelling in the midgut of an ixodid tick. Is there anything else that made it new?

WB: Of course. Also new was the wide spectrum of clinical manifestations caused by this spirochete. It was soon found to affect the ski, blood, muscle, joint and neurosystems with problems usually described for tick-borne spirochetes.

DB: Did you collaborate with additional people to do your follow up work that cinched the fact that this spirochete was the cause of Lyme disease?

WB: Dr. Russell Johnson of the Microbiology Department in the University of Minnesota, offered to work up the genetic material of this organism and compare it with the other Borrelia that are known. He found that it was a completely different organism that deserved a different name. Thus when during the first international symposium on Lyme disease held at Yale in 1983, the question was posed how to name this organism, the majority of my colleagues agreed to call it *Borrelia burgdorferi*.

DB: Because your last name is Burgdorfer.

WB: It was named after the one who discovered it.

DB: When a new microorganism is discovered, generally speaking, is there a standard procedure for giving it a name?

WB: Yes.

DB: And what is that procedure?

WB: The main procedure is to determine genetically the DNA composition of the organism. Molecular, and also physiological, studies are required before a new name is given according to the standards of the International Systematic of Bacteriology.

DB: So this organism would have been called Borrelia something, is that true?

WB: Yeah, it would have been. If for instance, the majority of my colleagues would have rejected the name *Borrelia burgdorferi*, it could have been named according to someone or something else.

DB: But it would have been called "Borrelia" something?

WB: Correct.

DB: So this is quite an honor to have it named after you.

WB: Oh yes. An exciting honor.

DB: And is it fair to say that this discovery is what you are most famous for?

WB: Now I wouldn't say famous. Let's call it "known for".

DB: "Known for", all right.

WB: There are other things I'm known for.

DB: But there's nothing else that has been named after you, is there?

WB: No.

DB: Are there any ticks that live in Montana that are known to carry *Borrelia burgdorferi* as far as you know?

WB: No. As far as I know, no.

DB: Has anyone done any work on that?

WB: No. There is no complete compiling of ticks from Montana, and the Ixodes species that we have are all very closely associated with the host animal. It is quite possible that a spirochete similar to, if not identical with, *Borrelia burgdorferi* may be maintained in the wild, but nobody has done any work along this line. As far as I know, there has never been a case of Lyme disease in Montana. The only cases seen in Montana are those that have been contracted back east in areas where Lyme disease is present.

DB: Has there been any work done to determine whether or not the eastern deer tick could survive in Montana?

WB: I don't think work has been done and I don't think it's necessary. You may have areas where the humidity conditions are such that the tick could survive. The most important thing for *Ixodes scapularis* for survival is high humidity. It's too dry in Montana for these ticks to survive for a long period of time. However, as I say that, in Utah, north of Salt Lake City in the Wasatch Mountains are conditions that allow for the survival of infected *Ixodes pacificus* . So it is not surprising that a few Lyme disease cases have been recorded from that region.

DB: So these little niches I take it are humid. Is that true?

WB: That's right, otherwise the ticks could not survive.

DB: And when you say they're infected, are they infected with *Borrelia burgdorferi*?

WB: Yes. They're related. Very closely related, and they still call them Borrelia burgdorferi, but there may be some additional sera types.

DB: Do you have any ideas or theories or thoughts on what would make the spirochetes from those ticks in Utah a little bit different from the spirochetes that were found in New York? Is it possible that the variations are caused by the environment?

WB: It has long been speculated that introduction of *Borrelia burgdorferi* into geographic foci with tick vectors and animal hosts different from those in endemic areas may lead to genetic as well as physiologic variations of these microorganisms. Such variations have been reported from ticks and tick hosts, but so far, not from humans as patients. In Europe, molecular and immuno-chemical analyses of spirochetes from ticks – from *Ixodes ricinus*; from host animals and humans, have classified *Borrelia burgdorferi* into three geno-species: *Borrelia burgdorferi sensu strictor*; *Borrelia garinii*, and *Borrelia afzelii. Borrelia burgdorferi* is found in North America and European countries, where it causes arthritic conditions. *Borrelia garinii* and *Borrelia afzelii* occur throughout Europe and Asia. They cause neurological disorders and cutaneous manifestations, respectively. Based on today's knowledge, these spirochetes and their variants occur independently from each other regardless of their tick/host associations. All these genotypes have been isolated from individual ticks as well as from individual patients.

DB: Is there work being done now at the Rocky Mountain Labs on the variance or the subspecies of *Borrelia burgdorferi*?

WB: Yes. Dr. Tom Schwan and Dr. Patricia Rosa continue to work on this. They were the ones who first discovered that Borrelia burgdorferi can be divided into subspecies.

DB: And has anyone determined for certain what causes these variances?

WB: No.

DB: So there's just a speculation about the causes?

WB: Yes, as far as the cause is concerned.

DB: Is there any test that has been developed now that can diagnose Lyme disease in a patient?

WB: As yet, there is no specific test for the diagnosis of Lyme disease. A patient's indication includes a history of tick bites and the subsequent development of clinical manifestations including skin, blood, muscle, nervous and joint disorders. For confirmation of the diagnosis, follow up laboratory tests are sometimes used.

DB: And what sort of further or follow up tests can be done to determine that?

WB: Lyme disease can be confirmed in the laboratory by isolation of the causative agent from a patient's blood, cerebrospinal fluid or skin tissues maintained in a liquid medium, or by detection of sero-antibodies specific to *Borrelia burgdorferi*. Although isolation of spirochetes from patients is recommended, the complexity of culturing techniques does not allow routine application. Once cultured, spirochetes can be identified as *Borrelia burgdorferi* by their reactivity with monoclonal antibodies or by assays detecting specific DNA of the organism. Various immunoassays such as direct and /or indirect immunofluorescence enzyme-linked immunosorbent assays, and Western immunoblot have been developed to determine a patient's antibody responses to *Borrelia burgdorferi*. Some of these tests, unfortunately, lack specificity and sensitivity, resulting in false positives as well as false negatives. A patient exposed previously to spirochetes invariably will show titers to *Borrelia burgdorferi* even though there is no clinical illness.

DB: Are people working on a test?

WB: Oh yes.

DB: You indicated that for some years before your discovery, Lyme disease was a health problem, that people were suffering from the symptoms and nobody figured out what caused them. When was this disease first identified in the United States?

WB: The first identification in Lyme, Connecticut, dates back to 1965.

DB: Is Lyme disease known to affect any animal other than human beings?

WB: Yes, it does affect dogs, horses, and cattle. ECM-like skin lesions have been reported in rabbits.

DB: Domestic animals?

WB: Domestic animals, yes.

DB: As far as you know, does it affect mice?

WB: Arthritis-like joint swellings have been reported in experimentally infected mice, but not in the deer mouse, *Peromyscus leucopus*, which is the principal reservoir, maintaining spirochetemias for its entire life.

DB: Does anyone know whether or not the deer mouse shows any other symptoms when it's infected?

WB: Unfortunately we can't check the feelings of the mice and most of the animals, so the answer is no.

DB: There are no other observable symptoms?

WB: No.

DB: And what about deer?

WB: Deer do circulate very few spirochetes in their bloodstream, but don't show detectable adverse effects.

DB: Dr. Burgdorfer, when did you retire from Rocky Mountain Labs?

WB: I retired from the Lab on the 6th of January, 1986.

DB: So about five years after you made this momentous discovery. What prompted your decision to retire in 1986?

WB: That's a difficult question. I think I started to realize that the research I used to do and was successful in doing has changed its character. Molecular and genetic biology have replaced the technologies I was able to apply to my studies. Since I had no basic training in these fields of science, I was unable to speak and understand the completely new language.

DB: After you retired in 1986, did you continue to maintain any relationship with the Rocky Mountain Labs?

WB: Oh yes. I was nominated Scientist Emeritus and that gave me the opportunity to continue my work for another 15 years.

DB: So you continued to do the work, but you were no longer on the payroll.

WB: No longer on the payroll.

DB: Who did you make the arrangements with to have the status of Scientist emeritus?

WB: I think first of all the director and the peers in Washington. As scientist emeritus I was supposed to have access to secretarial help. Also to office space and lab support. The nomination provided me an opportunity to finish some long-term experiments for which I needed animals and lab space.

DB: Did you still have access to ticks?

WB: Oh yes. I retained colonies of soft-shelled ticks for several years. I also maintained the microbial agents we had isolated and worked with. These cultures were eventually taken over by other staff members.

DB: So, the status was renewed every year and you had access to your office, lab and animals?

WB: And parking space.

DB: And I take it you had all the same tools you used to have. You had a microscope and a camera and so forth.

WB: Sure.

DB: And if you wanted somebody, for instance like Fred Hayes to help you, was that available to you also?

WB: Yes.

DB: Do you continue to have access to an office and lab at the Rocky Mountain Labs?

WB: Right now, the answer is no. The changes that have happened at the Rocky Mountain Laboratory have taken all the space that was available, and we have to wait until new renovation space is being phased in.

DB: And the labs right now are undergoing incredible renovation.

WB: That's correct, there's no place for anybody, especially not for a scientist emeritus.

DB: In addition to doing work at the lab after you retired, did you store any of your work records there?

WB: Yes.

DB: Are they still there as far as you know?

WB: Yes. In the basement.

DB: Until some additional arrangements are made for space for you, are you going to be able to continue to store those records there?

WB: I hope so. If not, I have no other choice but taking them home.

DB: But you will do that? You will take them and keep them at your home?

WB: I have a garage that is supposed to house a car. I could store my records there.

DB: So the materials will be preserved. Is that right?

WB: They will be preserved.

DB: When you continued to do work at the Lab after your retirement, did people continue to call you about tick-borne diseases?

WB: That's correct.

DB: Were these just lay people or were they colleagues?

WB: Phone calls have continued, mostly from Lyme disease patients who failed to persuade their physicians to continue with treatment. Even though I always emphasize that I am not a physician – not even able to suggest an aspirin, they insist that discussing their problems with the "expert" helps.

DB: In addition to that sort of help and support, did you examine ticks that people suspected may have infected them?

WB: Correct. I'm still doing that many years after retirement.

DB: And do you expect to continue to do that?

WB: No, right now I have no place to do the lab work or to handle ticks that may be infected.

DB: And in fact nobody wants to be around you while you're doing that. In the event that after this renovation is over you have space at the Lab again, would you continue to dissect ticks at the request of people?

WB: If necessary I would.

DB: And by "necessary," do you mean if somebody asked you to do it?

WB: If somebody asked, I'd be very happy to do that.

DB: Because you've done it all your professional life?

WB: It's part of the service.

DB: Speaking of that, were you ever paid for examining ticks at the request of either somebody from the lay public or your colleagues?

WB: No.

DB: Again, after your retirement did other scientists continue to contact you or seek to collaborate with you?

WB: Yeah. I was very active meeting with Dr. Schwan and others who are doing very similar research as I did. We periodically get together and discuss progress, objectives and so on.

DB: Dr. Schwan I believe is one of the doctors at the Rocky Mountain Labs that you mentioned had done work or was still doing work on the different areas.

WB: He is doing work on the relationship between spirochetes, the host animals, and the ticks.

DB: After you retired, do you have any idea or guess about how much of your time was devoted to scientific endeavors?

WB: That's hard to say. Did you say, "afterwards"?

DB: After you retired.

WB: Okay, initially let's say about 50 percent. That went down after five, six, seven years, to maybe 30, 35 percent. And it's now down to very, very little.

DB: By scientific endeavors I take it that you include more than just dissecting ticks. You continue to do other things since retirement. Is that true? Such as lectures and write.

WB: I have been lecturing every year during the Acarology Summer Program at Ohio State University and as a board member of the Lyme Borreliosis Foundation. I have been very active pursuing papers at its workshops and conferences on Lyme *borreliosis* and other tick-borne ailments. I also by invitation have attended – and served as keynote speaker – several national and international conferences. Writing papers and keeping up with correspondence also plays an important part of my retirement.

DB: And even though you say that your scientific work has dwindled considerably, when was your last publication?

WB: My last publication was I think in January of this year in one of the European journals. I was invited to submit a manuscript of my presentation I gave at the International Conference in Munich last year, and this was published in the European journal.

DB: So even when you talk about your work being less, you're still quite active. Is that true?

WB: Yeah, I'm still quite active. I'm still following the scientific achievement in the literature and there is so much literature it's almost impossible to do that, but being retired I can take some time out for this.

DB: I imagine one reason that your scientific work has slowed down somewhat is because you don't have space to do it. Is there any other reason that your scientific efforts have dwindled recently?

WB: Yeah, because I'm not an expert in the molecular and genetic biology.

DB: Going back to your pre-retirement days, right after your 1981 discovery, what was your main scientific interest or pursuit right after that discovery of the spirochete?

WB: The main interest was to follow up on the development of the spirochete, especially on the hypothesis that it's not only a transverse division as far as the multiplication of the spirochete is concerned, but also a highly complex development that involves the formation of cystic material and spore-like formations that are being formed by the spirochete as a defense mechanism against the immune system of the host. These problems we faced during my thesis but we didn't have the techniques and the molecular procedures or electron microscopy to follow this question up. I feel that the spirochetes do have a very complex system that does involve formations that are not recognizable as typical coiled spirochetes but rather as atypical material that may play a part in the infection of humans and other animals.

DB: Did this interest focus on spirochetes in general or more on the one spirochete*, Borrelia burgdorferi?*

WB: That is on the spirochete in general. I am absolutely convinced that the development of spirochetes is far more complex than we assume. They don't only divide by primary fission, but rather by very complex systems that are still not known and may surprise us as far as the etiology of spirochete in general is concerned.

DB: I know that you've published a great number of articles. Do you know how many you've actually published, either as the sole author or co-author.

WB: The last paper I published was number 225.

DB: How many of those deal with tick-borne diseases?

WB: Tick-borne disease or related to tick-borne diseases, I would say 215.

DB: So the vast majority.

WB: Vast majority has been the relationship between vector ticks and their pathogens. Also I did some virus work on mosquitoes -- another subject, but nevertheless we had one highlight I'm very proud of and that is the isolation of California encephalitis virus from wild animals. California encephalitis is a disease of humans known in the '50s, 60s. The virus had been isolated and characterized but nobody knew where the mosquitoes picked up the virus. I was lucky to demonstrate that the snowshoe hare in the Rocky Mountain region are the sole sources of infection, and still even today a lot of work is being done on California encephalitis virus.

DB: Did you learn this from studying hares locally?

WB: Yes. The hare from which we isolated this virus was trapped within a few miles of the Rocky Mountain Laboratory.

DB: Where did you find the hare?

WB: We found it on an approach to one of our trap lines, sitting in the middle of the road. We assumed that something was wrong with it because it didn't want to get away. So we obtained a blood sample for evaluation in the laboratory.

DB: You said it didn't want to get away. Do you mean it just sat there for you?

WB: Yeah.

DB: But it wasn't in a trap line?

WB: It was not in a trap line and we were on the road to our trap line.

DB: And when you examined the snowshoe hare's blood, what did you find?

WB: It paralyzed hamsters, guinea pigs and suckling mice with manifestations typical of a viral agent. It turned out to be the cause of California encephalitis – a mosquito-borne disease that is detectable so far only in humans.

DB: What year were you doing this work?

WB: In 1961.

DB: And did you publish an article dealing with it?

WB: Published in 1961.

DB: Dr. Burgdorfer, I'd like to have you talk briefly about the life cycle of the Ixodes tick, the eastern deer tick, that carries the *Borrelia burgdorferi* and I'm wondering, first of all, if you could tell us what time of year a person is most likely to get Lyme disease.

WB: Most likely in June and July. These are the months when the nymphal tick of *Ixodes scapularis* is very active. These nymphs had been infected in the previous year as larvae on an infected animal.

DB: Now when you say they've been infected on an infected animal, do you know what species of animal they become infected on?

WB: Most likely on a deer mouse, which occurs throughout the eastern part of this country, and is the most important source for infecting ticks.

DB: So the tick becomes infected and then in turn can infect other mammals?

WB: That's right. The acquisition of *Borrelia burgdorferi* by *Ixodes scapularis* is best described as follows: In late July, August and early September, the larval ticks feed on reservoir-competent mice, *Peromyscus leucopus*, that had been infected by nymphal ticks in late May, June, and early July. They then spend the winter in the duff of the soil, and in the spring of the following year they molt into nymphs. They will feed in late May, June and July; and molt into adults that feed and mate during December and early spring. Each female lays about 2-to-3,000 eggs in a single cluster in May, June, or early July.

DB: Is the likelihood of infection from the adult tick less because there are fewer spirochetes in the adult tick?

WB: No, there are just as many spirochetes, but humans discover adult ticks faster than a nymphal tick. Adult ticks are considerably larger; one can see them and remove them much faster than a nymphal tick.

DB: Before the tape ran out, you were explaining why it is that a person is more likely to be infected by a nymphal tick in the summer than by an adult tick in the fall. Why is that?

WB: One of the reasons is that the adult tick is considerably larger -- up to 5 millimeters -- than the nymphal tick, and is much easier to detect than a nymph.

DB: So the size of the nymph is about the size of a freckle or something like that?

WB: Yeah, about 2 millimeters long.

DB: So you can see it with the naked eye but it's not easily visible?

WB: The nymphal tick?

DB: Yeah.

WB: It's very, very difficult to see, and only too often it is taken for a freckle without legs.

DB: After the tick becomes an adult, what does it do?

WB: It mates.

DB: Where do they mate?

WB: They mate on vegetation, as well as on its principal host, the deer. Once engorged, the females detach, drop to the ground, and crawl to the duff areas of soil.

DB: Where do the females feed? Is that on the deer?

WB: Yes. They feed on the deer or on any host animal that's available. They feed on dogs, for instance. Then the females lay their eggs into the duff area of the soil. As I described, in early July the larval ticks will come out and they will feed on small rodents such as deer mice. The important thing is that the larval ticks become infected from feeding on spirochetemic animals that received their infection from nymphal ticks.

DB: What becomes of the adults after they mate?

WB: The female will lay its eggs and after it is spent, will die – as will the male.

DB: Are the eggs a source of infection as far as anyone knows?

WB: There is some evidence that transovarial transmission may occur, but it is rare and appears to be of no ecological significance.

DB: Is it usual in the tick world for ticks to bite humans in the immature stage, in the larva stage?

WB: No, it all depends on the species. Larva and nymphs of the Rocky Mountain wood tick, for instance, do not feed on humans; only the adults do. Other species of ticks, like Boophilus microplus spend all three developmental stages on one and the same host. They are referred to as one-host ticks. There are two-host ticks that spend their life cycle on tow specific hosts, and there are three-host ticks whose larval, nymphal and adult stages feed on three different animals. *Ixodes scapularis* is a three-host tick. All developmental stages feed on a large variety of animals, including humans.

DB: About how long does the nymphal stage last?

WB: Well, for several months. They can stay active for four or five months.

DB: And again, that's in the spring and summer of the year?

WB: Right.

DB: What does the tick look like if you look at it under a microscope?

WB: Under a microscope, huge. The larva has six legs, and the nymphs and adults have eight legs. The hypostome with which the tick anchors itself to the host is plainly visible under the scope.

DB: What is the hypostome?

WB: The hypostome is an exoskeleton protrusion with which the tick anchors itself into the skin of the host. It has several rows of hooks that prevent dislodging of the tick from its host animal. It assures the attachment.

DB: Are these hooks bent backwards?

WB: Yes.

DB: So that the tick then can't just slide out after it has attached itself to a victim?

WB: No, it can't.

DB: It sounds like quite an ugly critter. Despite that, does it present any danger to human beings if it's not infected with *Borrelia burgdorferi*?

WB: Oh yes, a tick can be, of course, infected with other pathogens, not only spirochetes. And once a tick is attached to the skin of a person, because of the hypostome morphology it's very hard to dislodge. The best thing is just to take tweezers and grab the hypostome where it is attached to the skin of the host and then carefully pull it out.

DB: What other sorts of organisms infect the eastern deer tick? Let me just limit that to what other organisms that might be dangerous to human beings can infect the eastern deer tick?

WB: *Ixodes scapularis* has been found infected not only with spirochetes, but also with babesia, a protozoan agent causing *babesiosis*. In addition, this tick has been found infected with ehrlichia, a rickettsial agent causing in humans a mild spotted fever-like disease.

DB: Are any of the eastern deer ticks uninfected with anything?

WB: Oh yes. Well, there is no such a thing as a normal tick. All ticks have symbiotic structures that under some conditions may become infectious for humans. Another thing too is once you dislodge a tick, there always may be the chance that segments of the mouth parts are left in the bite wound, and may lead to secondary infection.

DB: From the wound itself.

WB: From the contamination of the wound.

DB: Are these other diseases that can be transmitted by the eastern deer tick, curable by antibiotics?

WB: Some are, yeah. When you catch it early, when the diagnosis of Lyme disease is done early, antibiotics are very effective. The same is true when somebody is suffering from ehrlichiosis, or babesiosis. These diseases can be treated.

DB: With antibiotics?

WB: With antibiotics, yeah.

DB: Again, how can a person determine whether an eastern deer tick, or a population of eastern deer ticks, is a carrier of *Borrelia burgdorferi*?

WB: Just by examining ticks, and by examining-- I suggest the tick is being dissected and parts of the mid gut and intestinal tract are being examined by dark field and/or fluorescence microscopy.

DB: The life cycle of the tick is very complex as you explained to us. Back in 1981 did scientists know about the life cycle of the eastern deer tick? Did they understand it?

WB: I think yes, I think we understood it, because the Ixodes species are world-wide distributed and *Ixodes ricinus* especially in Europe is the most common tick there. It's a sheep tick that has been subject of intensive studies as far as the biology of the tick throughout Europe is concerned.

DB: You described the appearance and life cycle of the Ixodes tick that carries the spirochete, and you've told us earlier what the spirochete itself looks like. How does it move?

WB: How does the spirochete move?

DB: Yes.

WB: As I mentioned *Borrelia burgdorferi*, like other spirochetes, have flagella inserted at both ends of the spirochete and they overlap in the middle of the organism. These flagella are responsible for the movements of the organism.

DB: Can it move backwards and forwards?

WB: Yes. Forward; backwards.

DB: Or does it have a backwards or forward?

WB: There is no back or front. But, if you looked at it under the microscope, they go in all directions. That's the fascinating thing about watching spirochetes.

DB: How does it reproduce?

WB: It reproduces by binary fission that is one hypothesis, and as I mentioned before, there's a possibility that they also produce by very complex development, including cysts and granules that may be part of the complex development cycle. That's now being investigated in many laboratories throughout the world. Spirochetes are back.

DB: So there's a lot of work to be done?

WB: There's a lot of work to be done. There's a lot of work to be done on the physiology of the spirochete and that very likely will have some bearing on the clinical manifestations caused by these organisms.

DB: You've alluded to this previously, but could you set forth how this spirochete, the *Borrelia burgdorferi*, actually gets from the midgut of an infected tick into the human being, into the victim.

WB: It appears that ingestion of blood during a tick's feeding initiates the passage of spirochetes from the midgut through the gut epithelium and via hemolymph, into the various tissues, including salivary glands.

DB: After *Borrelia burgdorferi* enters the human skin, where does it go?

WB: That's a very good question. It's assumed that they get rapidly into the bloodstream and are carried throughout the system of the host animal, invading the various tissues including the central nervous system.

DB: And again, in order to start this process, the tick first has to ingest its victim's blood. Is that true?

WB: That is true.

DB: And how long does that take usually?

WB: Studies done so far suggest that it takes about two days of attachment and feeding before spirochetes are being transmitted to a host animal. This is referred to as the "safety period," during which a person could remove a tick without becoming infected. I personally don't subscribe to this theory, because there are about 5 to 10 percent of infected ticks that have a generalized infection, including salivary glands and saliva at the time of attachment. In such cases, transmission of spirochetes would and does occur immediately at time of attachment.

DB: So the longer process is only the case for ticks that carry spirochete only in the midgut.

WB: Correct.

DB: And, of course, it was in the midgut that you found your spirochete the first time.

WB: Correct.

DB: As far as you know, is there a relationship between the location of the spirochete in the human victim and the clinical manifestations of Lyme disease?

WB: Well, we know that spirochetes are surrounding the erythema migrans lesion and we know that the spirochete can be isolated from the blood and even from the cerebral spinal fluid of a patient.

DB: Dr. Burgdorfer, have you yourself seen *Borrelia burgdorferi* in any locations in the tick other than in the midgut?

WB: Yes. We have followed the development of *Borrelia burgdorferi* in individual ticks and especially the passage of the organism through the gut wall into the body cavity. We also have found them in salivary gland tissues and especially in the ovarian tissues. There they can affect the egg to the point that it will die. So we have seen them throughout the tissues throughout the tick, as we also find in the case with relapsing fever Borrelia.

DB: When you're saying "we've seen that", you yourself have seen that. Is that right?

WB: Yeah.

DB: And have you yourself done any work to determine how the spirochete is transferred from the tick into its victim?

WB: Oh yes. As far as the Lyme disease spirochete is concerned, it's via saliva, saliva being injected during the feeding process. There are other tick species, like *Ornithodoros moubata*, where a fluid referred to as “coxal fluid” is being ejected into the bite wounds or is diffusing through the skin of a host, and if this fluid is infected with spirochetes, the spirochetes are capable of either to enter into the bite wound or diffusing through the skin and producing an infection.

DB: And the coxal fluid is something other than saliva?

WB: Yeah. The coxal fluid occurs in certain, not all, soft ticks like *Ornithodoros moubata*. It originates from a gland which is referred to as the coxal gland that filters the fluid taken up during the tick's feeding. Fluid of no biological value is being ejected, giving the tick the ability to ingest more blood.

DB: But the Ixodes tick does not have any this coxal fluid. Is that right?

WB: That’s correct.

DB: So it sounds like you've done work not only to determine the manner of transfer of *Borrelia burgdorferi* into a victim, but you've done research that helps explain the manner of transfer of other disease-causing organisms from other ticks. Is that right?

WB: Yes.

DB: Dr. Burgdorfer, you said that you've worked on preventing tick-caused diseases by working on educating the public, and you talked about some of the educational efforts that you've undertaken. Could you talk in a little more detail about some of the educational tools that you've worked on to try to educate the public about ticks and tick-borne diseases.

WB: Yes. I have prepared slide shows and articles about ticks and the cautions that should be taken in tick-infested countries. One can do actually a lot, such as proper clothing and even tick repellents to prevent ticks from attacking you. I have also done a lot of lecturing, of course, in schools starting with kindergarten classes, showing youngsters how ticks look like and what to do if one finds a tick.

DB: So your interactions with people in terms of talking about ticks and tick-borne diseases has spanned the whole spectrum from kindergarden age children to colleagues, Ph.D.s and M.Ds. Is that right?

WB: That's correct. And it's very important that this is being continued, because education is the best means of prevention.

DB: And that's especially true for diseases caused by ticks?

WB: Correct.

DB: I know that we've talked and actually laughed about this before, Dr. Burgdorfer, but given the fact that the spirochete isn't a very lovely creature, how do you feel about having a spirochete named after you?

WB: It's an honor to have my name attached to the pathogen I studied throughout most of my career.

DB: And, of course, it's especially an honor since the reason that the name is there is that you discovered the creature.

WB: Correct. At least the creature that causes Lyme disease.

DB: Right. Since 1984, have you received any other special recognition for discovering the spirochete that we now call *Borrelia burgdorferi*?

WB: Oh yes. There's a long list of awards and presentations I have gotten. The list includes the Schaudinn-Hoffman Plaque, from the German Society of Dermatology; the Robert Koch Gold Medal from Germany; the Bristol Award, from the Infectious Disease Society of America; and the Walter Reed Medal, from the American Society of Tropical Medicine and Hygiene. Also, I have received the Distinguished Achievement Award from the American Society of Vector Ecology. I have been selected a Corresponding Member of the Swiss Academy of Medical Sciences, and have been elected a Fellow of the American Society of Microbiology. I have gotten two Doctors of Science honoris causa, from Ohio State University, and from Montana State University; and I have gotten two M.D. degrees, also honoris causa, one from the University of Bern in Switzerland and one from the University of Marseilles in France.

DB: For the awards that you've received and the honorary degrees that you received in Europe, did you go over to Europe to receive them?

WB: That's correct.

DB: And was there a ceremony involved with the presentations.

WB: With every one of them.

DB: And were those enjoyable ceremonies?

WB: Oh yes, very, very enjoyable because I was able to speak the language of the people that issued the awards in Germany, as well as in France, and that always made it quite nice to be able to correspond with foreign colleagues.

DB: You've said that you have published about 225 papers that you've either authored by yourself or with others. How many of those published works have been written since you officially retired from Rocky Mountain Labs?

WB: Sixty-seven articles, most of these dealing with Lyme disease and tick-borne spirochetes.

DB: When was your most recent paper published?

WB: The most recent one was in the European Journal of Clinical Microbiology and Infectious Diseases, in January 2001.

DB: And what was the topic of that recent paper?

WB: The topic of that had to do with the relationship of the spirochetes in the arthropod vectors. It was a general paper on the behavior of the spirochetes.

DB: Do you plan on writing any other articles for publication?

WB: If the opportunity arrives, I certainly will.

DB: Are many of your most recent articles written in response to requests from other people?

WB: That's true. Because few of today's molecular biologists are aware of the circumstances that led to the discovery of spirochetes, I have been asked on various occasions to present historical reviews on research that led to the current knowledge of these arthropod-borne microorganisms.

DB: And that's because you've been involved in this field of study for so long and have such a sense of history of the research. Is that right?

WB: That is true. And also because I collected most of the articles on certain subjects. I kept up with the reviews and I am able to pull out the original articles and compare their findings with what is being presented today.

DB: Again, you're continuing to keep track of the research that is done in this field. Is that right?

WB: As much as I can.

DB: You've already talked about the fact that you have lectured a great deal. Does this lecture activity, or is this lecture activity something that continued after you officially retired from Rocky Mountain Labs?

WB: Yes.

DB: Is that because you have more time?

WB: Yes. And also because the scientific articles from other laboratories continue to result in an increased number of publications that shed additional light on the subject.

DB: So you're saying that you're able to see your work with a different perspective now that additional work has been done?

WB: Correct. That's work actually throughout the world.

DB: What was the most recent lecture that you've given?

WB: The most recent one was in Munich at the International Conference on Lyme disease and tick-borne diseases. That had to do with the physiology of the spirochete.

DB: Did you give that lecture in English or German, or both?

WB: I gave it in English because the official language in these international conferences is English.

DB: When you go to these meetings, these professional meetings, are you recognized by the other attendees?

WB: Yeah, hopefully I am. I don't want to blow my own horn here, but so far, my work has been recognized world-wide.

DB: So you're keeping in contact with people who know your work and know you.

WB: That's correct.

DB: Have all of the lectures that you've given since your retirement been related to Lyme disease, or have you given lectures on other tick-borne diseases?

WB: I've given lectures on other tick-borne diseases, but the majority of the recent lectures, talks and discussions have been on Lyme disease and related spirochetoses.

DB: Have more of these lectures been in the United States, or have more been in Europe?

WB: More have been in the United States. As a member of the Lyme Borreliosis Foundation, I have been asked to give lectures at every congress or every workshop supported by it.

DB: So that means that you're going to continue to get requests to give lectures. Is that right?

WB: Correct.

DB: And do you plan on continuing to do that?

WB: Yeah, as long as I'm healthy and as long as I am able to keep up with the literature and with the findings in this field, I'll be glad to do so.

DB: It sounds like you maintain pretty close contact with scientists who are working on tick-borne diseases both at Rocky Mountain Lab and elsewhere. Is that true?

WB: Yes.

DB: And you've already mentioned some of the scientific professional organizations that you're a member of. How many scientific professional organizations do you belong to?

WB: Actually, right now I have a membership in four societies. I used to be a member of six additional societies, but no longer belong to them.

DB: What four societies are you a member of?

WB: The American Society for Rickettsiology, the Lyme Borreliosis Foundation, the Swiss Academy of Medical Sciences, and the American Society of Microbiology.

DB: Two of those groups are involved with the two organisms that you've done most of your work on: That is the rickettsiae and the spirochetes.

WB: Correct.

DB: You already indicated that even after you retired, you continued to dissect and examine ticks. Did you examine these ticks at somebody's request?

WB: Yes. I got periodic requests from state health departments and physicians submitting ticks off patients – also from individuals wanting to know whether ticks removed from them and from their pets are carriers of pathogens. This “tick examination service” had to be terminated, since I no longer have access to laboratory facilities. As before, people worrying about tick bites and resulting clinical manifestations were referred to their physicians.

DB: Did you examine ticks after you retired in order to determine if any particular population was infected?

WB: After I retired?

DB: Yes.

WB: Yes. But the only work on the distribution of infected ticks concerned the distribution of *Borrelia burgdorferi* Lyme disease spirochete infected ticks. And these surveys were conducted in various parts in this country, as well as abroad, especially in Europe.

DB: So people would send you ticks from a given location to determine whether or not there was an infected population there?

WB: Yes, but no longer on a large basis. I usually refer people to the research literature that describes in detail how to go about dissecting ticks. Entomologists should be able and capable of following these instructions and conducting dissections in their own laboratories.

DB: And those instructions are your instructions. Is that right?

WB: Well, they were included in my original paper.

DB: And then did you also dissect any ticks after your retirement that were given to you by local people?

WB: Yes, I did, but only for people who had a tick attached, and wanted to know if it was infected with the agent of Rocky Mountain spotted fever. During the first five years after retirement, I evaluated ticks from thirteen people. Five of those were infected with rickettsia-like organisms that proved non-pathogenic for humans.

DB: So, for local people, you were always looking for the pathogen that causes Rocky Mountain spotted fever?

WB: Yes. That is the one we worry about in this area.

DB: Going back to when you first came here, of course, you were brand new to America and certainly brand new to Montana and Hamilton, this is back in the beginning of the 1950's, did you have any problems adjusting to the new environment over here?

WB: None at all. No, not at all.

DB: It felt like home to you?

WB: Yes. The Bitterroot Valley in western Montana is the area that I liked the best, and compares quite nicely with the Alpine region in Switzerland.

DB: But you're happy that you landed here it sounds like.

WB: Oh yes.

DB: When you first arrived back in the 50's, did you join any organizations? Any local organizations?

WB: Yes, I joined the Elks Club and more recently the Kiwanis.

DB: When you were working at Rocky Mountain Labs, did you participate in any community affairs?

WB: Yes, through the Kiwanis Club. The Kiwanis International is an organization that has a very close relationship with the population wherever the Club exists.

DB: So your participation in those organizations, Kiwanis and the Elks, and your work at Rocky Mountain Lab, introduced you to a whole circle of people in the community it sounds like.

WB: Correct. Especially the Kiwanis. I was president of the local Kiwanis Club and also served as Lieutenant Governor of Kiwanis International for the District of Montana for two consecutive years. And believe me that brought me into close touch with the people in Hamilton and Montana.

DB: I know that in addition to these community activities and your professional work, you've been married to your wife Dale for more than 40 years. And you and she had children.

WB: Yes. We've two boys.

DB: Did you raise them in Hamilton?

WB: We raised them in Hamilton, yes.

DB: Did you consider that a good place to raise children.

WB: It's a beautiful place to raise children, but unfortunately once they get past the high school, they are gone, continuing their careers away from home.

DB: Did both of your boys go to university?

WB: Yes.

DB: Did either one of your sons go into scientific research, by the way?

WB: One started studying microbiology but after about one or two years, he decided this was not his field and he got into the financial field. He liked that much better. The older boy is an amateur astronomer. He studied astronomy. After two years, he also decided this was not his field, and he took up accounting at the University of Montana, in Missoula.

DB: So they're both working in the financial field now.

WB: Both, that's right.

DB: Hopefully that will be helpful to you. Do either of the boys live in Montana? Or the young men, they're not boys any more.

WB: Yes. Bill the older one has an accounting firm in Dillon, Montana.

DB: And where does Carl live?

WB: Carl lives in Eugene, Oregon, and he's associated with U. S. Bancorp.

DB: You've already told us that your wife was working as a secretary and technician at the Rocky Mountain Lab when you met her. Did she continue to work after your marriage?

WB: She continued to work until the first boy came along. That was about two years.

DB: You've already told us that you and your wife Dale lived in a house in downtown Hamilton after you got married. Did you continue to live there after the children came?

WB: Yes, we did.

DB: And is that the same house you're living in today?

WB: It's the same house we live in today.

DB: And again, that's just a number of blocks from the Rocky Mountain Labs. Is that right?

WB: Yes, it's only two and a half blocks.

DB: When you were working at Rocky Mountain Labs, I take it that made it easier to go back and forth to the laboratory to do work.

WB: Fortunately and unfortunately.

DB: You told us that you worked past midnight sometimes.

WB: I spent a lot of time at the Laboratory.

DB: So it was almost too easy for you to spend time at your lab. Is that right?

WB: That's correct.

DB: When you were working full time at the Labs, were you able to spend much time with your family?

WB: I think I spent considerable time with the family, although maybe not as much as I should have -- because it was so easy to go back to continue or finish the work that you started during the day, instead of spending time with the children. But in spite of that, I spent a lot of time with the children playing soccer and going fishing, teaching them outdoors and so on. We had a good time together.

DB: Living in Hamilton, of course, made it easy to do these outdoor activities. Is that right?

WB: That's correct. Those kids knew more about fishing spots here in the Bitterroot River than I did, and whenever we went together they caught just as many fish as I did.

DB: Do they come back here to fish and to enjoy the environment here?

WB: Maybe not to fish, but certainly enjoy coming back and enjoy to play golf, so we still have a good time together. It has gotten more competitive, however, and Dad is no longer in first place.

DB: Going back to the work schedule at the Lab where you said you went back to work and sometimes worked past midnight, do you think that this sort of dedication and focus that you spent on your work at Rocky Mountain Labs is required in order for a scientist to become and remain prominent in his or her field?

WB: Well, it certainly is not required, but it will help to keep up with what is going on in other laboratories, and is responsible for the accomplishments for writing papers and all that. Without this dedication probably I never would have reached that point where I am today.

DB: And again you've written at least 225 papers, written or written with others, at least 225 papers that have been published. And that just takes a lot of time. Is that right?

WB: Certainly. Especially if you have to learn first how to write papers.

DB: And you talked about that, in 1951 having to learn almost from scratch how to write a paper. I take it you got that down though since you have written quite a few. You figured out how to write papers.

WB: Yes.

DB: And in fact you've helped others write papers since then.

WB: Yes.

DB: Since you retired, have you continued to engage in community activities in Hamilton?

WB: Yes, I have as a Kiwanian, at the Kiwanis Club. I've been very active.

DB: Back to when you were talking about participating in soccer with your children, were you actively involved in soccer in Hamilton when your children were growing up?

WB: Yes, I was. I was one of those who introduced soccer to the Bitterroot Valley.

DB: And where did you become introduced to soccer?

WB: At home in Basel, Switzerland. Soccer is the sport that everyone can play. It is a popular sport in Europe, especially in Switzerland. I always maintained that soccer would be an equally popular sport here in the United States. The past few years have shown that I was right. When we started this in the Bitterroot, we had 120 children playing soccer. Today we have a very complex league that involves more than 600 boys and girls.

DB: Are you involved in the soccer program in Hamilton anymore?

WB: No more. I used to coach, referee and even broadcast games on local T.V.

DB: You know children who are actively involved in it?

WB: Oh yes. Once in a while somebody comes up and says, "Hi, Willy, do you remember me? I used to be your striker or I used to be your goalie."

DB: It sounds like you spend a lot of time still keeping up with work done in your field, and then you do the Kiwanis work. I know just from passing by your house that you spend an awful lot of time maintaining a beautiful flower garden. What is the majority of your time and energy spent on these days?

WB: Right now, in taking care of my wife. She unfortunately had a fall two years ago and had to have brain surgery. During surgery she suffered a stroke, and is now severely handicapped.

DB: So that is the prime interest and activity that you're engaged in at this time?

WB: That's correct.

DB: Dr. Burgdorfer, looking back over things, it sounds like you're happy that you moved to Hamilton more than 50 years ago. Can you say that you are glad that you moved here?

WB: Very, very happy. I was fortunate that everything sooner or later fell into place and so I have all the reasons, every reason, to be happy.

DB: And then specifically, how do you feel about your career at Rocky Mountain Laboratory looking back over it?

WB: Looking over my career, I can only say it was a good one, a very productive one. It was an exciting career, and I am happy that my colleagues, not only in this country but also in Europe, agree with me.

DB: And you said it was a good career. From what you've told us you're still working in your field, and I take it, it still is a good career. Is that right?

WB: Yes. I still have a lot of correspondence on the various subjects I worked on, more especially on the late subject and that is Lyme disease and its spirochete.

DB: Thank you very much.

End of Interview